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Application for Construction Permit:

R. J. REYNOLDS ASH MANAGEMENT AREA

RURAL HALL, NORTH CAROLINA

Prepared for:

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1.0 INTRODUCTION

1.1 Background

This section will provide a general description of the location of the proposed R.J. Reynolds Ash Management Area and the regulatory requirements that will govern permitting in accordance with the North Carolina Solid Waste Management Rules. The site is being permitted to handle non-hazardous, inert waste flyash from the R.J. Reynolds facilities.

1.1.1 Site Description

The proposed R.J. Reynolds Ash Management Area is located off Highway 66 approximately one mile northeast of Rural Hall, North Carolina, as shown on Drawing 3. The site in situated in the Town Fork Watershed of Forsyth County with Leak Creek bordering the site along the eastern boundary. The land use in the area in primarily farming and timbering with a few scattered residences in the area.

Several areas adjacent to and south of the project site have been used as a flyash disposal area by R.J. Reynolds for the last 10 years. These areas have been permitted previously with the North Carolina Department of Environment, Health, and Natural Resources as Phase 1, Phase 2, and Phase 2 Alternate.

1.1.2 Previous Studies

Engineering Tectonics, P.A. of Winston-Salem, North Carolina prepared a Site and Construction Application in 1986 for the Phase 1 flyash landfill. The work for this project involved drilling test borings and developing preliminary hydrogeologic information for the project site.

In 1987, Law Engineering developed the Application for Construction Permit for Phase 2 and Phase 2 Alternate. This application included a more in-depth hydrogeologic investigation and the installation of three monitoring wells in the vicinity of the Phase 2 flyash disposal area. This information is not included with this application, but it was useful in the evaluation of hydrogeologic conditions at the project site.

In 1989, KBK Enterprises performed a coal combustion ash characterization study. This study involved testing the coal combustion ash from several R.J. Reynolds facilities to determine its physical and chemical properties. The E.P. Toxicity results from this study have been used to assist in the fate transport evaluation that is included as part of this Construction Permit Application.

1.1.3 Utilization and Operation

The R.J. Reynolds Ash Management Area (RJRAMA) will receive non-hazardous, inert industrial flyash (coal combustion ash) from the R.J. Reynolds facilities. The facility is projected to receive approximately 10,000 cubic yards of ash monthly and is designed for a capacity of approximately 120,000 cubic yards. A breakdown of the ash quantities, estimated cover soil, and final cover soil is provided on Drawing 4.

The facility is operated by a private excavation company under contract to R.J. Reynolds. Ash is deposited at the disposal area using dump trucks and spread using a bulldozer and front end loader. Due to the relatively incompressible nature of flyash in comparison to other solid wastes, specialized compaction equipment is not necessary. The flyash is compacted using several passes with the dozer and then graded to provide adequate drainage of stormwater runoff.

To minimize the amount of infiltration into the coal ash waste material, the RJRAMA has been divided into three sub-areas that will maximize the amount of stormwater that is diverted from the disposal area. A more detailed explanation of the stormwater management and operation procedures is provided in Section 6.0, Basis of Design.

1.2 Regulatory Framework

1.2.1 State Regulations

At the time of the preparation of this permit application, regulations did not exist for dedicated flyash disposal areas in the State of North Carolina. A draft from the NCDEHNR dated February, 1993 (refer to Appendix IV) for land reuse areas addresses flyash as a potential fill material, but it is our understanding from numerous conversations with NCDEHNR officials in the Solid Waste Section in Raleigh that a dedicated facility the size of the RJRAMA would not fit into the category of a land reuse project due to its size and the nature of the disposal operation.

A review of the State regulations suggests that the R.J. Reynolds coal combustion ash would be considered inert debris if adequate waste and site characterization is provided. The North Carolina Hazardous Waste Management Act defines inert debris as being "solid waste which consists solely of material that is virtually inert and that is likely to retain its physical and chemical characteristics under expected conditions of disposal." The current State statutes unfortunately do not provide any additional guidelines as to how a solid waste is technically determined to be inert. As part of this Construction Permit Application, GCI will attempt to determine whether the R.J. Reynolds coal ash is "inert" and will retain its physical and chemical

characteristics under the expected conditions of disposal. This will be accomplished by using existing chemical testing data, a design which incorporates groundwater protective operational procedures, and the MULTIMED computer model from the US-EPA Region IV for a determination of fate transport for expected constituents in the coal ash material.

In response to our conversations with Ms. Sherie Hoyt and Mr. James Coffey of the NCDEHNR Solid Waste Section, this Construction Permit Application has been developed in general accordance with the Land Clearing and Inert Debris (LCID) Landfill application requirements of 15A NCAC 13B. To provide an additional measure of the groundwater quality beneath the site, an abbreviated hydrogeologic study was also conducted in accordance with the general siting criteria for disposal sites in Section .0503 of 15A NCAC 13B. Prior to conducting the hydrogeologic assessment, GCI had the workplan reviewed by Mr. Bobby Lufty, a hydrogeologist in the Solid Waste Section.

According to the NCAC regulations, LCID landfills do not require compacted soil or synthetic liners at this time. Discussions with Ms. Hoyt of the NCDEHNR Solid Waste Section indicated that due to the dedicated nature of the proposed coal ash disposal activities at the R.J. Reynolds facility that waste characterization and some type of fate transport study would be required to justify an unlined facility. To provide a conservative approach to this requirement, the minimum performance criteria at the compliance boundary is considered to be the NCAC 2L groundwater standards. The MULTIMED computer program from the US-EPA was used to develop the fate transport evaluation with infiltration rates developed by the Hydrologic Evaluation of Landfill Performance (HELP) computer model.

1.2.2 Regulations from Nearby States

In order to develop an understanding of the approach to the regulation of coal ash disposal landfills in other States, a literature search was conducted to determine feasible alternatives for environmentally sensitive disposal. The following is a summary of regulations from four neighboring states.

South Carolina is currently in the process of developing its regulations for coal ash and other non-hazardous industrial wastes. From conversations with the South Carolina DHEC, it is our understanding that industrial landfill regulations will have a tiered approach to liner and monitoring requirements. If the expected contaminant level at the compliance boundary is less that the Maximum Contaminant Level (MCL), then no liner is required. For industrial waste facilities with expected groundwater contaminant levels between 0 and 10 times above the MCL, then a clay liner with leachate collection is required. It is expected that coal ash disposal facilities with adequate characterization of the waste and fate transport studies will be considered under the no liner requirement in most areas with some minor exceptions due to local soil conditions.

The State of Virginia currently provides exemption from regulation for coal combustion ash if it is used as a roadway sub-base or as a structural fill material. Coal combustion ash is also exempt from landfill regulation if it is used in a mine reclamation project permitted by the Virginia Department of Mines, Minerals and Energy. It is our understanding that dedicated coal ash disposal facilities are regulated under the VDEQ industrial landfill regulations. VDEQ industrial landfill regulations require a 30-mil synthetic liner for most industrial wastes, but allow a no liner variance if adequate waste characterization and fate transport evaluation is provided using the US-EPA MULTIMED program. Based on our review of the regulations and the

characteristics of coal ash, it is expected that VDEQ will allow a no liner facility if adequate waste characterization is provided.

Georgia and Alabama also have a tiered industrial landfill approach to the regulation of coal combustion ash disposal. Both of these states allow an unlined facility if adequate technical support is provided to indicate compliance with the Maximum Contaminant Levels at the compliance boundary. For technical support of an unlined industrial waste disposal facility, Georgia and Alabama require waste characterization using the US-EPA Toxicity Characteristic Leach Process (TCLP) and fate transport analysis using the MULTIMED computer program.

As indicated by the summary of regulations from neighboring states, it appears that coal combustion ash is most frequently regulated as a low contaminant level, generally inert, industrial solid waste. Unlined facilities are definitely allowed in all neighboring states if adequate waste characterization and fate transport evaluation is provided. This approach is also consistent with the US-EPA Subtitle 'D' approach to the regulation of municipal solid waste that allows less stringent liner design if adequate demonstration of compliance at the waste facility compliance boundary is provided. This is the approach that was used for the development of the facility design for the R.J. Reynolds Ash Management Area to ensure compliance with the most recent environmental regulations.

2.0 SITE GEOLOGY AND HYDROGEOLOGY

2.1 Subsurface Exploration Activities

The subsurface exploration to identify pertinent geologic and hydrogeologic features consisted of drilling eight (8) Standard Penetration Test borings at representative locations on the project site. Two of the test borings were completed as monitoring wells to allow long term monitoring of the groundwater in the upper most water bearing strata. The other six test borings were terminated at the top of rock and a temporary piezometer was installed to measure perched waters levels in localized areas on top of the bedrock.

As part of the subsurface investigation, representative samples were obtained for laboratory testing including grain size analysis, soil classification according to the Unified Classification System, saturated hydraulic conductivity, total porosity, and Atterberg limits. Boring logs from the wells and test borings are provided in Appendix I. The laboratory test results are also provided in Appendix I.

2.2 Geologic Description

The project site is located in the Piedmont Physiographic Province, an area underlain by metamorphic and ancient igneous rock. The bedrock directly beneath the project site generally consisted of a grey mica schist with intermittent layers of biotite-muscovite gneiss. The residual soil profile in the area is generally characterized by reddish brown, clayey silt near the surface transitioning into brown sandy silts and silty sands at greater depths. The interface between the residual soils and bedrock interface is not sharply defined with a transition zone of saprolite and/or weathered rock varying in thickness from 6 inches to 20 feet.

2.3 Hydrogeologic Description and Potential Migration Pathways

Groundwater was encountered within the bedrock and in localized perched water areas on top of the bedrock. The localized perched water areas were encountered approximately 2 to 5 feet above the top of bedrock in borings B-9, B-10 and B-12. Based on the elevation of groundwater indicated on the groundwater contour map and the lack of groundwater in adjacent borings and wells, it appears that the perched groundwater is located in isolated pockets in the bedrock surface. To verify that there was a substantial difference in the water levels in the perched water areas and the uppermost water bearing strata, temporary piezometers were installed in all of the test borings and read at least 72 hours after installation to ensure a steady state condition. Although this perched water is not a seasonal high groundwater table, it may still need to be managed/controlled periodically during the construction of the facility.

During drilling no groundwater was encountered in the residual soil profile in monitoring wells W-4 and W-5. Air percussion rotary drilling techniques were used to advance the well borings into the fractured mica schist bedrock. The groundwater for wells W-4 and W-5 appeared to be located in rock fractures with a confined aquifer condition that caused the water elevations to rise significantly above the initial depth where the groundwater was encountered. Based on the observations of the GCI project geologist at the time of drilling, the groundwater appeared to be located in fractures at 143 feet and 6 feet below the ground surface in monitoring wells W-4 and W-5, respectively.

The purpose of the monitoring well installation is to provide representative sampling of the uppermost water bearing strata. Due to the large amount of relief on the site (i.e., over 150 feet from ground surface at monitoring wells W-4 to W-5) difficulties were encountered in intercepting the water table with the screened interval in the upgradient monitoring well W-4. At the time of drilling the well appeared dry to a depth of 185 feet with possible low producing fractures at 143 feet and 158 feet below the ground surface. To ensure that producing fractures were intercepted, the well boring was allowed to remain open for a 24

hour period and then the screened interval was then placed from a depth of 138 to 188 feet. The placement of the well screen and conditions at the site were discussed with Mr. Bobby Lufty of the Solid Waste Section at the time of well construction to verify that the location of the screened interval was in general accordance with the NCDEHNR guidelines for monitoring well construction at landfills.

Based on the groundwater elevations developed from monitoring wells W-3, W-4, and W-5 in the general vicinity of the R.J. Reynolds Ash Management Area, the groundwater appears to flow in a southeasterly direction with a maximum hydraulic gradient of 0.05 ft/ft. Laboratory permeability tests of undisturbed test samples indicated that the saturated hydraulic conductivity of the residual soil profile ranges from 3.6×10^{-4} cm/sec to 3.1×10^{-6} cm/sec. In-situ permeability testing of the bedrock aquifer was beyond the scope of the subsurface investigation and is not required by the 15A NCAC 13B regulations for the siting of land disposal facilities. For computation purposes and to provide a conservative estimate of contaminant transport, GCI has assumed a hydraulic conductivity of the mica schist bedrock of 1.5×10^{-5} cm/sec. The groundwater contour map for the project site is shown on Drawing 5.

At the time of permitting there were no drinking water wells or other potential receptors within 1/4 mile downgradient of the project site. Several residences with drinking water wells are located just outside a 1/4 mile radius of the site, but the significant amount of topographic relief in this area strongly suggests that the groundwater beneath the RJRAMA site is intercepted by Leak Creek that borders the eastern boundary.

At this time the only upgradient well is the water supply well for the RJRAMA. This well is used primarily for industrial purposes and is not considered a drinking water source and/or a potential receptor of contaminants from the disposal area.

3.0 WASTE ASH CHARACTERISTICS AND CONTAMINANT TRANSPORT

3.1 Physical and Chemical Characteristics

Bituminous coal combustion ash is typically made up of Silica Oxide (SiO_2), Ferric Oxide (Fe_2O_3), and Alumina Oxide (AlO_3). The ash may also contain trace amounts of other oxides, alkalies, and volatile organic compounds. Flyash has been used for many years as a roadway base and sub-base fill material and has a soil classification similar to that of a silt or fine silty sand.

3.1.1 Mechanical Properties

The coal ash that will be disposed of at the R.J. Reynolds Ash Management Area was tested extensively by KBK Enterprises in 1989 to develop an indication of its physical and mechanical properties. The following is a summary of the results of the soil mechanics laboratory testing performed by KBK Enterprises:

Bailey Plant Mechanical Properties Test Data

Soil Classification - Silt, poorly graded
Maximum Dry Density - 65.5 pcf
Optimum Moisture - 46 %
Compression Index - 0.07

Tobaccoville Plant Mechanical Properties Test Data

Soil Classification - Silt, poorly graded
Maximum Dry Density - 48.6 pcf
Optimum Moisture - 69.8 %
Compression Index - 0.41

Whitaker Park Plant Mechanical Properties Test Data

Soil Classification - Silt, poorly graded
Maximum Dry Density - 63.0 pcf
Optimum Moisture - 43 %
Compression Index - 0.25

3.1.2 Chemical Properties

The coal combustion ash from the R.J. Reynolds facilities is regularly analyzed for EPA Priority Pollutant Metals using the Toxicity Characteristic Leach Procedure (TCLP). The TCLP test results for the coal combustion ash provide a "worst case" indication of leaching potential in a low pH environment. When the TCLP analysis for heavy metals is used in conjunction with fate transport modeling procedures, it provides a measure of the "worst case" condition for potential environmental impact. The TCLP analysis was used to provide the initial concentrations of metals for the MULTIMED analysis, but it is important to note that this low pH condition is never expected to occur at the RJRAMA.

3.2 HELP Model Evaluation of Leachate Flow

To determine the expected leachate production volume from the R.J. Reynolds Ash Management Area, the Hydrologic Evaluation of Landfill Performance (HELP) Model was used to produce estimates for the various disposal area subcells (refer to Appendix III). A standard cross section with medium permeability final cover, 50 feet of compacted coal ash, 10 feet of clayey silt and a 4 foot sandy silt overburden layer (refer to Typical Landfill Section in Appendix III) was used for a series of HELP model runs depicting the expected condition that will exist at the two subcells that are closest to the disposal area compliance boundary. The average exfiltration rate from the bottom of the ash disposal area was computed to be 0.0023 in/yr by the HELP Model. This exfiltration rate from the HELP

Model was then used as the infiltration rate for the MULTIMED model to compute contaminant fate transport.

3.3 MULTIMED Model Evaluation of Contaminant Transport

A typical cross section was used for the MULTIMED analysis at three different distances from the compliance boundary. To provide a "worst case" evaluation of contaminant transport through the underlying soil and rock, the highest TCLP initial concentration was used for the three metals concentrations (i.e., Barium, Chromium, and Selenium) that are closest to the NCDEHNR 2L Standards. The chemical input parameters for the model were developed from the Application Manual for MULTIMED and soil properties were developed from the HELP Model user's manual and soil laboratory testing conducted as part of the subsurface investigation.

Chemical decay and dispersivity coefficients were allowed to be developed by the program with a slight increase in the absorption coefficient to account for the natural tendency of metals to absorb onto soil particles. The following is a summary of the expected contaminant levels as computed by the MULTIMED model for the RJRAMA facility:

Constituent:	Selenium
NCDEHNR 2L Standard:	0.01 mg/l
Trial No. 1A	
Initial Concentration:	0.05 mg/l
Distance from Compliance Boundary:	1200 feet
Computed Concentration:	0.000000000026 mg/l
Trial No. 2A	
Initial Concentration:	0.05 mg/l
Distance from Compliance Boundary:	500 feet
Computed Concentration:	0.0000061 mg/l

Trial No. 3A

Initial Concentration:	0.05 mg/l
Distance from Compliance Boundary:	100 feet
Computed Concentration:	0.0024 mg/l

Constituent:	Chromium
NCDEHNR 2L Standard:	0.05 mg/l

Trial No. 1B

Initial Concentration:	0.084 mg/l
Distance from Compliance Boundary:	1200 feet
Computed Concentration:	0.000000000043 mg/l

Trial No. 2B

Initial Concentration:	0.084 mg/l
Distance from Compliance Boundary:	500 feet
Computed Concentration:	0.000010 mg/l

Trial No. 3B

Initial Concentration:	0.084 mg/l
Distance from Compliance Boundary:	100 feet
Computed Concentration:	0.0040 mg/l

Constituent:	Barium
NCDEHNR 2L Standard:	1.0 mg/l

Trial No. 1C

Initial Concentration:	0.66 mg/l
Distance from Compliance Boundary:	1200 feet
Computed Concentration:	0.00000000034 mg/l

Trial No. 2C

Initial Concentration:	0.66 mg/l
Distance from Compliance Boundary:	500 feet
Computed Concentration:	0.000080 mg/l

Trial No. 3C

Initial Concentration: 0.66 mg/l
Distance from Compliance Boundary: 100 feet
Computed Concentration: 0.031 mg/l

TABLE 1 MULTIMED MODEL RESULTS				
CONSTITUENT	INITIAL CONCENTRATION (mg/l)	DISTANCE FROM COMPLIANCE BOUNDARY (ft).	COMPUTED CONCENTRATION AT COMPLIANCE BOUNDARY (mg/l)	NCDEHNR 2L STANDARD (mg/l)
Selenium	.05	1200	.000000000026	.01
Selenium	.05	500	.0000061	.01
Selenium	.05	100	.0024	.01
Chromium	.084	1200	.0000000000043	.05
Chromium	.084	500	.000010	.05
Chromium	.084	100	.004	.05
Barium	.66	1200	.000000000034	1.0
Barium	.66	500	.000080	1.0
Barium	.66	100	.03	1.0

As indicated by the test results provided above, the expected contaminant levels at the compliance boundary are well within the 2L Standards. It is important to note that the MULTIMED analysis was performed using estimated parameters for absorption and chemical dispersivity coefficients. The initial concentration levels for the constituents that were evaluated were developed from the TCLP test procedure that develops a "worst case" scenario of potential contaminant transport.

The cross section that was evaluated during the MULTIMED analysis had no bottom liner and the primary buffer between the coal combustion ash and the groundwater was the residual soil profile and fractured mica schist bedrock. Based on the results of the MULTIMED analysis, it appears that a "no liner" alternative is a feasible alternative for the R.J. Reynolds Ash Management Area. The relatively low expected contaminant levels are most likely due to the low permeability residual soils and the low initial concentration of contaminants in the coal ash material.

4.0 ADHERENCE TO SURFACE SITING CRITERIA

The surface siting criteria that were used in the design of the R.J. Reynolds Ash Management Area were developed from the general disposal site criteria and LCID criteria in 15A NCAC 13B. The following sections provide general explanations of how these criteria are followed during the disposal area siting.

4.1 Surface Water Criteria, 100-Year Flood, and Wetlands

The proposed coal ash disposal area is located in a steeply sloping ravine which extends in a west to east direction. Surface elevations range from 860 along the eastern boundary to 1000 along the western boundary. The ravine averages 700 feet in width and 80 feet in depth. Stormwater travels down the slopes of the ravine, into a partially eroded, shallow collector channel along the base of the ravine that drains eastward to Leak Creek.

Leak Creek, located along the eastern boundary of the R.J. Reynolds property, is not a regulated floodway by the Forsythe County engineering department or the Federal Emergency Management Agency (FEMA). The limits of this project are located 50 vertical feet and 500 horizontal feet from Leak Creek, and provide adequate distance to ensure that the project is outside the limits of the 100 year flood limits of Leak Creek and neighboring surface bodies of water.

There are no areas on the property of the proposed ash management area, with the exception of the limits of the stream channel for Leak Creek, which exhibit the characteristics of wetland hydrology, as defined by the U.S. Army Corps of Engineers. A review of the Forsyth County Soil Survey indicates that the project site has no soils that are considered hydric (i.e., wetland supporting) soils. Due to the lack of wetland hydrology and/or hydric soils, it was determined that a wetlands delineation and the identification of wetland vegetation was not necessary to eliminate the potential for non-tidal wetlands at the project site.

4.2 Endangered Species Habitat, Archaeological Sites, and State Parks

Based on a conversation with the N.C. Wildlife Resources Commission, it is our understanding this project will not cause or contribute to the taking of any endangered or threatened species of plants, fish or wildlife and shall not result in the destruction or adverse modification of the critical habitat of endangered or threatened species. This preliminary determination will also be confirmed by a letter to the N.C. Wildlife Resources Commission showing the location and proposed development at the project site (see letter in Appendix IV).

Based on a conversation with the State Historic Preservation Office, this project is not expected to cause damage or destruction of an archaeological or historical site and will not cause an adverse impact on a state park, recreation area or scenic area, or any other lands included in the state nature and historic preserve (see letter in Appendix IV).

4.3 Seismic Considerations

Based on a review of seismic activity maps, it appears that the project is located within an area with generally low seismic activity. The maximum expected peak horizontal acceleration in an expected seismic event, with a probability of one event every 250 years, is estimated to have a seismic horizontal acceleration coefficient of 0.10g as determined by

seismic mapping developed by Algermisson. Based on recent literature from the US-EPA governing the siting of landfill in seismic areas, a horizontal acceleration of 0.10g or less should not require special design considerations. Furthermore, the RJRAMA project does not have any leachate collection facilities or liner systems which may be damaged during a typical seismic event.

4.4 Zoning and Property Line Setbacks

The property is zoned R-6 by Forsyth County, which is considered a rural, residential classification. At the time of the preparation of the permit application, the Forsyth County Zoning Ordinance had no text regarding the land disposal of coal combustion ash, subsequently they are unable to categorize and regulate this project (see attached letter in Appendix IV). Numerous conversations with Forsyth County zoning officials indicated that they may respond to the request for zoning depending on the response of the NCDEHNR to the Construction Permit Application. These officials have also requested that they be notified of any new developments with the project or permitting process.

The minimum setbacks as set forth by the North Carolina Department of Environment, Health and Natural Resources for solid waste disposal sites are as follows:

- 50 foot buffer between all property lines and disposal areas.
- 500 foot buffer between private dwellings and wells and disposal areas.
- 50 foot buffer between streams and rivers and disposal areas.

The proposed coal ash disposal area is well within compliance of all setback criteria outlined above, as shown in Drawings 2 and 3.

Deed references, tax parcel identification, and adjoining property information was provided by R.J. Reynolds for the ash management area. This is supplied on Drawing 3 of the Construction Permit Application drawings.

4.5 Suitability of the Surface Soils for Landfill Operation

The near surface soils are generally suitable for intermediate cover and the construction of landfill berms if adequate procedures are used for excavation, placement and compaction. The near surface soils are generally reddish brown clayey silts and sandy silts with medium plasticity. Some of the near surface clayey silts may require drying during wet seasons prior to placement and compaction.

For the construction of intermediate berms and structural fill areas, a minimum percent compaction of ninety five percent of the maximum dry density as determined by ASTM D-698 is recommended. The fill material should be placed in maximum eight loose lifts and compacted with suitable compaction equipment. A summary of the mechanical properties of the near surface soils present at the project site is provided in Appendix I.

5.0 ADHERENCE TO GROUNDWATER AND SUBSURFACE SITING CRITERIA

5.1 Foundation Stability

Foundation stability is normally not a concern for coal ash disposal facilities due to the relatively light unit weight of coal ash as compared to conventional construction materials and the relatively large area where the material will be placed. Based on the result of the subsurface investigation, we anticipate that the maximum increase in stress in the residual soil profile will be 9,000 to 10,000 psf. The coal ash will be placed in a staged operation that should allow the effective dissipation of porewater pressure, thereby decreasing the potential for subsurface instability. The Standard Penetration Test resistance values generally indicated that the foundation soils at the R.J. Reynolds Ash Management Area are suitable for the support of the bearing stress that will be developed by the coal ash disposal operation. This statement concerning bearing capacity does not address building foundations constructed at the project site or the potential for deep rotational slope

instability which would require additional analysis that are beyond the scope of this permit application.

5.2 Depth to Seasonal High Groundwater Table

At the time of the subsurface evaluation the minimum depth to the uppermost water bearing strata was approximately 10 feet. This area was located near the bottom of the ravine where a shallow drainage feature was located. During our field activities some evidence of periodic releases of localized perched water was evident through fractures and openings in the surficial soils and bedrock outcrop near the bottom of the ravine. To account for this condition and to provide for the minimum four foot buffer between the bottom of the disposal area and the seasonal high water table, a shallow under drain will be installed. The under drain will be located at the bottom of the ravine in the drainage channel and will be constructed of No. 57 stone covered with a minimum 4 foot buffer of low permeability, compacted clayey silt. A geotextile separation layer will be placed between the stone and the compacted clayey silt to prevent the migration of fine particles.

5.3 Groundwater Quality at the Compliance Boundary

As required by State and Federal regulation for waste disposal facilities, the natural features of the project site are expected to cause the contaminant levels to be well below the NCDEHNR 2L Standards and the Federal Maximum Contaminant Levels at the compliance boundary. As required by the NCDEHNR regulations, the compliance boundary is located 100 feet within the property line. Monitoring wells have been placed upgradient and downgradient of the site and are located on the compliance boundary.

The determination of expected contaminant levels at compliance boundary was developed using the US EPA MULTIMED program. This program provides an indication of the fate transport of contaminants that are released from the project site and takes into

consideration a variety of chemical and hydrogeologic features. A more detailed explanation of the procedures used for the fate transport evaluation is provided in Section 3.0.

6.0 BASIS OF DESIGN

This section provides a description of the general design and regulatory principles that were considered in the design of the R.J. Reynolds Ash Management Area. Additional support documentation and engineering computations are provided in Appendices II and III.

6.1 Stormwater Management

For stormwater management design purposes, the project area is defined as having a hilly topography classification with cross slopes ranging from 10 to 45 percent across the majority of the site. This pre-development topography creates a high amount of runoff in relation to rainfall percentage, resulting in a high runoff coefficient. Upon completion of filling activities at the project site, the site grades have been designed to range from 5 to 10 percent, creating a reduction in the runoff coefficient for the overall site and decreasing the overall runoff volume from the site.

The concentration of runoff into the perimeter swales, which slope from 1.5 to 5.0 percent, was designed to create a longer time of concentration for stormwater impacting the site. The longer distance of travel and the flat slopes on the swales create a detention condition which reduces the maximum discharge and velocity of stormwater from the project area.

The swales were designed for a 10 year storm intensity, an industry standard for on-site stormwater management. The swales were designed based upon the velocity of flow in the channels resulting from post development conditions. The criteria for the design of the swales is as follows:

1. Grassed swales with no erosion control blanket require maximum velocities less than or equal to two feet per second.

2. Grassed swales with erosion control blanket require velocities to be less than five feet per second and greater than two feet per second.

3. Riprap swales require velocities to be greater than five feet per second.

The velocity criteria for the grassed swales is based on the performance standards for tall fescue (uncut) seeded in accordance with the seeding manufacturers specifications.

A rock dam sediment basin will be constructed immediately downstream from the filling activity on each phase of the project. The rock dam sediment basin has proven to be a highly stable and reliable means of retaining sediment discharge from land disturbing activities. The basins are sized according to an average sediment discharge of 1800 cubic feet per acre.

The stormwater management basin is located downstream of all filling activities and serves as both a detention and retention facility. The dewatering holes in the riser are sized for an eight hour discharge of the pond, while the stone filter surrounding the riser retains any sediment which may bypass the upstream basins. The stormwater basin acts as a wet pond in filtering the overall runoff from the site and reducing the discharge of suspended solids. This feature will allow the stormwater management basin to decrease the quantity and increase the overall quality of discharge from the project site.

6.2 Grading Plan

The proposed grades for the project were aimed at maximizing fill quantities, while minimizing the cross slopes to achieve a useable area with a mild gradient upon cessation of filling activities. Such use may include a public recreation area or similar facility to enhance the communities park and recreation lands or simply open grassed pasture potentially useful for agricultural production.

The slopes of the facility were designed for a maximum of 3H to 1V to increase the overall stability of the slopes and decrease the potential for erosion channels. These slopes are the recommended maximum slopes for standard landfilling operations.

The projected life of this project is fifteen years, based upon the available fill volume over the site and the volume of ash generated at the R.J. Reynolds facilities.

6.3 Groundwater Monitoring Plan

The groundwater monitoring network that was installed during the initial subsurface investigation provided by GCI in May 1993 consists of one upgradient and one downgradient well. A second downgradient well that was installed by Law Engineering during previous phases will be utilized for this portion of the project also. The recommended sampling interval is bi-annually with the sampling parameters consisting of the EPA Priority Pollutant Metals. These test results would be required to be in compliance with the NCDEHNR 2L Standards.

6.4 Surface Water Monitoring Plan

Leak Creek is currently being sampled bi-annually upstream and downstream of the existing landfilling activities on the R.J. Reynolds property (refer to Drawing 3 for existing stream sampling locations). Since 1990 there have been no detectable increases in the

concentrations of constituents regulated by the NCDEHNR 2L Standards (refer to Appendix III for laboratory sampling results for SS-1 and SS-2). Surface water monitoring will be continued into the future on a bi-annual basis at the proposed locations indicated on Drawing 3.

Through the adequate sedimentation and erosion control measures currently being utilized and the additional measures proposed for this project, it is anticipated that there will be no effect on the surface water leaving the RJRAMA facility.

6.5 Operational Procedures

R.J. Reynolds has successfully established and proven field techniques for managing the disposal, placement and compaction of coal ash over steep slopes, while minimizing site erosion from ash fill.

The coal ash will be hauled into the project daily and disposed of in the staging areas conveniently located along the uppermost limits of each sub-area. At the end of each day, a bulldozer pushes the accumulation of material towards the downgradient end of the filling area, progressively compacting the material under the weight of the ash. Borrow areas are also typically established along the ridge lines of sub-areas, accessible from the maintenance road. These borrow areas are established to generate suitable soil cover material for ash and to create additional volume for the disposal areas. Borrow areas will also be established within Sub-Area A for cover material to be used in the existing ash disposal areas on the R.J. Reynolds property.

Due to the self compressibility of the R.J. Reynolds coal ash, progressive end-dumping practices have proven to be the most effective means for disposing of the coal ash in a manner which maximizes the local stability of the fill areas and minimizes the overall area under disturbance at a given time. Temporary seeding measures will also be used to minimize short term erosion of denuded slopes within an active sub-area. Diversion ditches

will be maintained at all times around the perimeter of the filling operations to minimize surface water on the denuded areas. All fill areas shall be sloped to discharge stormwater without creating small pools of standing water. The contractor will diligently and continuously maintain all erosion control measures on a daily basis wile a sub-area is active. Refer to Drawing 9 for the construction sequence to be adhered to on this project.

6.6 Perched Water Drain

The shallow drainage channel at the base of the ravine periodically allows drainage of perched water from isolated pockets in the bedrock surface. To adequately control this intermittent drainage, the bottom of the channel will have an under drain placed under the coal ash fill. The under drain will be discharged downstream from all filling activities into the stormwater basin, as shown on the project drawings. Low permeability structural fill will be compacted in six to eight inch lifts over the shallow under drain to a minimum depth of 4 feet to provide adequate separation from the coal ash in accordance with the NCDEHNR guidelines. The low permeability fill will be compacted to ninety-five percent of its maximum dry density in accordance with ASTM D-698 and will have a maximum permeability of 1×10^{-6} cm/sec. All coal ash fill will be maintained at a minimum of 4 feet above the seasonal high water table, conservatively established as the top of the under drain for design purposes.

The under drain will be constructed with No. 57 washed stone covered with a 5 oz. non-woven geotextile to prevent migration of fine grained soil particles.

6.7 Final Cover and Facility Closure

The on-site soils appear to be generally suitable for use as landfill cover material. Suitable on-site clayey material shall be compacted to ninety-five percent of the maximum dry density and are expected to obtain a maximum permeability of 1×10^{-6} to 1×10^{-7} cm/sec, if placed

with adequate moisture and compaction control. Since the underlying soils have permeabilities in the range of 1×10^{-4} to 1×10^{-5} cm/sec, this type of final cover material will provide an overall reduction in infiltration through the coal ash fill material and reduce the potential for a ponding of leachate in the bottom of the landfill. In accordance with the NCDEHNR regulations, the cover material will be placed and compacted in six to eight inch loose lifts to a minimum depth of two feet.

Temporary seeding measures will be implemented on denuded areas within active sub-areas as necessary to maintain site stability over large work areas. Permanent seeding to be implemented on all denuded areas brought to finish grades (see the project drawings for seeding specifications).

Each sub-area will be inspected by a representative from the NCDEHNR for compliance with the sedimentation and erosion control objectives on a regular basis and will receive final closure approval after the commencement of filling in a completed sub-area.

Sediment basins serving sub-areas which receive final closure will be maintained until such time that vegetative cover is established on the area which it serves. After vegetative cover has been established, the basin may be removed. The stormwater basin is not expected to be impacted by substantial quantities of sediment runoff and will remain a permanent feature of the project site after final closure to provide the detention, retention and water quality functions for which it was designed. Under expected conditions and adequate installation of erosion control measures per the design plans, the stormwater basin should be maintained for approximately 10 years after the completion of the coal ash filling project.

ABR\RJRPERM1.REP

APPENDIX I

(Boring Logs and Soils Laboratory Data)

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011**

DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **W-4** **(1 of 5)** Total Depth **193.0'** Elev: **1014±** Location: **See Drawing 5**

Type of Boring: **HSA/Air Hammer** Started: **5/17/93** Completed: **5/17/93** Driller: **D. Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
		Stiff, brown and red clayey SILT with trace mica, damp (MH)					
				5.0			
			6/6/7	6.5			
1004.4	10.0			10.0			
		Stiff, tan sandy SILT, with little mica, moist (ML)	5/5/4	11.5			
				15.0			
			7/7/9	16.5			
994.4	20.0			20.0			
		Stiff, brown micaceous sandy SILT, moist (ML)	6/8/10	21.5			
				25.0			Grout (0-127')
			8/8/9	26.5			
				30.0			
			8/10/12	31.5			
979.4	35.0			35.0			
		Dense, brown and grey micaceous silty SAND, trace of weathered rock fragments, moist (SM)	12/13/15	36.5			
				40.0			
			23/50-3"	40.6			
				45.0			

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011** DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **W-4** **(2 of 5)** Total Depth **193.0'** Elev: **1014±** Location: **See Drawing 5**

Type of Boring: **HSA/Air Hammer** Started: **5/17/93** Completed: **5/17/93** Driller: **D. Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
			26/50-3"	45.6			
966.4	48.0	AUGER REFUSAL @ 48.0 FEET. NOTE: Begin Air Hammering @ 48.0' Sulfidic biotile-muscovite gneiss interlayered with mica schist and minor amphibolite, unweathered, hard, dry.					2" Sch 40 PVC Casing (0-138')

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011**

DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **W-4** (3 of 5) Total Depth **193.0'** Elev: **1014±** Location: **See Drawing 5**

Type of Boring: **HSA/Air Hammer** Started: **5/17/93** Completed: **5/17/93** Driller: **D. Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
914.4	100.0						Bentonite (127-131')

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011**

DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **W-4** **(4 of 5)** Total Depth **193.0'** Elev: **1014±** Location: **See Drawing 5**

Type of Boring: **HSA/Air Hammer** Started: **5/17/93** Completed: **5/17/93** Driller: **D. Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
871.4	143.0	Some possible fractures present					
							Sand Pack (131-188.6')
							2" Sch 40 PVC Screen .01" Slot (138-188.1')
836.4	178.0	Chlorite schist, greenish grey, medium grained, schistosity well developed, dry					

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011** DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **W-4** **(5 of 5)** Total Depth **193.0'** Elev: **1014±** Location: **See Drawing 5**

Type of Boring: **HSA/Air Hammer** Started: **5/17/93** Completed: **5/17/93** Driller: **D. Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
825.8	188.6	BORING TERMINATED @ 188.6 FEET.					

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011** DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **W-5** **(1 of 1)** Total Depth **24.0'** Elev: **858±** Location: **See Drawing 5**

Type of Boring: **HSA/Air Hammer** Started: **5/17/93** Completed: **5/17/93** Driller: **D. Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
		Firm, brown and red clayey SILT, with little mica, moist (MH)	1/3/4	0.0 1.5			
854.0	4.0	AUGER REFUSAL @ 4.0 FEET. NOTE: Begin Air Hammering @ 4.0 Feet. Mica schist, grey hard slightly weathered, dry					Grout (0-10') 2" Sch 40 PVC Casing (0-13') Bentonite (10-12') Sand Pack (12-24')
842.0	16.0	Mica schist, grey hard slightly weathered, damp					2" Sch 40 PVC Screen .01" Slot (13-23.5')
834.0	24.0	BORING TERMINATED @ 24.0 FEET. NOTE: Groundwater Encountered @ 6.0 Feet at Time of Drilling.					

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011** DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **B-9** **(1 of 1)** Total Depth **23.0'** Elev: **963±** Location: **See Drawing 5**

Type of Boring: **Hollow Stem Auger** Started: **5/20/93** Completed: **5/20/93** Driller: **Ron Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
		Stiff, brown and red clayey SILT with little mica, trace weathered rock fragments, damp (MH)		2.3			
			5/7/9	3.8			
958.0	5.0			5.0			
		Very stiff, brown and red, sandy SILT with little mica, moist (ML)	2/6/14	6.5			Cuttings (0-15')
953.0	10.0			10.0			
		Very stiff, brown sandy SILT with trace of mica and weathered rock fragments, moist (ML)	5/12/13	11.5			2" Sch 40 PVC Casing (0- 18')
948.0	15.0						
		Very dense, brown micaceous silty SAND, moist (SM)		15.6			Bentonite (15-16')
			50-6"	16.1			Sand Pack (16-23')
				20.0			
			50-4"	20.5			2" Sch 30 PVC Screen .01" Slot (18-22.5')
940.0	23.0						
		AUGER REFUSAL @ 23.0 FEET.					
		NOTE: Groundwater encountered @ 16.8 feet 24 hours after completion of drilling.					

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011**

DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **B-10** **(1 of 1)** Total Depth **14.0'** Elev: **933±** Location: **See Drawing 5**

Type of Boring: **Hollow Stem Auger** Started: **5/19/93** Completed: **5/19/93** Driller: **Ron Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
		Stiff, brown clayey SILT with trace of mica and weathered rock fragments, damp (MH)					Cuttings (0-6')
928.0	5.0			5.0			2" Sch 40 PVC Casing (0-9')
		Stiff, brown and grey, micaceous clayey SILT with little sand, damp (MH)	12/15/21	6.5			Bentonite (6-7')
							Sand Pack (7-14')
923.0	10.0			10.0			
		Very dense, brown micaceous sandy SILT, moist (ML)	50-1"	10.5			2" Sch 40 PVC Screen .01" Slot (9-13.5')
919.0	14.0						
		AUGER REFUSAL @ 14.0 FEET.					
		NOTE: Groundwater encountered @ 11.2 feet 48 hours after completion of drilling.					

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011** DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **B-11** **(1 of 2)** Total Depth **54.0'** Elev: **912±** Location: **See Drawing 5**

Type of Boring: **Hollow Stem Auger** Started: **5/20/93** Completed: **5/20/93** Driller: **Ron Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
911.5	0.5	TOPSOIL					
		Stiff, brown and red clayey SILT with trace mica, damp (MH)					
				5.0			
			8/8/8	6.5			
902.0	10.0			10.0			
		Stiff, tan sandy SILT with trace mica, moist (ML)	5/6/7	11.5			
897.0	15.0			15.0			
		Stiff, brown SILT with little mica, trace fine sand, moist (ML)	7/5/7	16.5			
				25.0			
			5/7/8	26.5			
				30.0			Cuttings (0-45')
			7/9/11	31.5			
				35.0			
			12/12/16	36.5			2" Sch 40 PVC Casing (0-48')
872.0	40.0			40.0			
		Dense, brown and grey silty SAND, little mica, with trace of weathered rock fragments, moist (SM)	25/30/30	41.5			

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011**

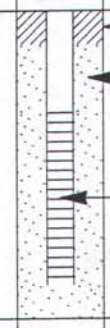
DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **B-11** **(2 of 2)** Total Depth **54.0'** Elev: **912±** Location: **See Drawing 5**

Type of Boring: **Hollow Stem Auger** Started: **5/20/93** Completed: **5/20/93** Driller: **Ron Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
							Bentonite (45-46') Sand Pack (46-54') 2" Sch 40 PVC Screen .01" Slot (48-53')
858.0	54.0	AUGER REFUSAL @ 54.0 FEET. NOTE: No Groundwater Encountered During Time of Drilling.					

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011**

DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **B-12** **(1 of 1)** Total Depth **8.5'** Elev: **912±** Location: **See Drawing 5**

Type of Boring: **Hollow Stem Auger** Started: **5/19/93** Completed: **5/19/93** Driller: **Ron Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
		Firm, brown and red, clayey SILT with little mica, damp (MH)	2/4/4	0.0 1.5			Cuttings (0-1') Bentonite (1-2') 2" Sch 40 PVC Casing (0-3.5') Sand Pack (2-8.5')
				5.0			
	▼		10/12/14	6.5			2" Sch 40 PVC Screen .01" Slot (3.5-8.0')
903.5	8.5	AUGER REFUSAL @ 8.5 FEET. NOTE: Groundwater encountered @ 6.4 feet 48 hours after completion of drilling.					

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011**

DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **B-13** **(1 of 1)** Total Depth **5.5'** Elev: **880±** Location: **See Drawing 5**

Type of Boring: **Hollow Stem Auger** Started: **5/19/93** Completed: **5/19/93** Driller: **Ron Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
878.0	2.0	Firm, brown and red Clayey SILT with trace mica, damp (MH)	2/4/5	0.0 1.5			
874.5	5.5	Soft, grey sandy SILT with trace of clay and mica, moist (ML)					
		AUGER REFUSAL @ 5.5 FEET. NOTE: No Groundwater Encountered During Time of Drilling.					

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011** DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **B-14** **(1 of 2)** Total Depth **54.0'** Elev: **970±** Location: **See Drawing 5**

Type of Boring: **Hollow Stem Auger** Started: **5/20/93** Completed: **5/20/93** Driller: **Ron Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
		Firm, brown and red clayey SILT with trace mica, damp (MH)	3/3/4	0.5, 2.0			
			5/6/7	5.0, 6.5			
960.0	10.0			10.0			
		Stiff, brown sandy SILT with little mica, trace clay and weathered rock, moist (ML)	5/5/7	11.5			
955.0	15.0			15.0			
		Stiff, tan sandy SILT with little mica and trace of weathered rock fragments, moist (SM)	5/7/10	16.5			
			5/5/12	20.0, 21.5			
			9/19/20	25.0, 26.5			
940.0	30.0			30.0			Cuttings (0-45')
		Dense, grey and tan silty SAND with little mica and weathered rock fragments, moist (SM)	12/19/27	31.5			
			28/50-6"	35.0, 36.0			2" Sch 40 PVC Casing (0-48')
			30/50-6"	40.0, 41.0			
				45.0			

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

BORING LOG

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Report No.: **93011**

DATE: **June 8, 1993**

Client: **R. J. Reynolds Tobacco Company**

Project: **R. J. Reynolds Coal Ash Management Area Forsythe County, NC**

Boring No.: **B-14** **(2 of 2)** Total Depth **54.0'** Elev: **970±** Location: **See Drawing 5**

Type of Boring: **Hollow Stem Auger** Started: **5/20/93** Completed: **5/20/93** Driller: **Ron Brown**

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	* Sample Blows	Sample Depth (Feet)	OVA (PPM)	WELL LOG	REMARKS
			~~50-3"~~	45.5			Bentonite (45-46')
							Sand Pack (46-54')
							2" Sch 40 PVC Screen .01" Slot (48-53')
916.0	54.0	AUGER REFUSAL @ 54.0 FEET.					
		NOTE: No Groundwater Encountered During Time of Drilling.					

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

SUMMARY OF LABORATORY TESTING

R. J. REYNOLDS ASH MANAGEMENT AREA

GCI JOB NO: 93011
CONSTANT HEAD PERMEABILITY TEST
ASTM D 5084

I. Date of Test: June 7 - 11, 1993

II. Test Locations: B-12 (0.0' - 2.0')

III. Material Description: Reddish Brown Clayey SILT

IV. Material Condition: Undisturbed Sample

V. Proctor Data:
Maximum Dry Density (pcf): ND
Optimum Moisture Content (%): ND

VI. Test Data:

Dry Density (pcf):	101.0
Initial Moisture Content (%):	18.3
Final Moisture Content (%):	21.7
Sample Length (cm):	5.08
Sample Area (cm^2):	42.08
Head (cm):	140.68
Quantity of Water Passing Through Sample (cm^3):	21.9
Elapsed Time (sec):	1200
Temperature (°F):	73
Viscosity Correction Factor:	0.931
Coefficient of Permeability -k (cm/sec):	1.5×10^{-5}

VII. Comments: Consolidated and tested at 2 psi head difference.

SUMMARY OF LABORATORY TESTING

R. J. REYNOLDS ASH MANAGEMENT AREA

GCI JOB NO: 93011
CONSTANT HEAD PERMEABILITY TEST
ASTM D 5084

I. Date of Test: June 7 - 11, 1993

II. Test Locations: B-9 (2.3' - 4.3')

III. Material Description: Reddish Brown Clayey SILT

IV. Material Condition: Undisturbed Sample

V. Proctor Data:
Maximum Dry Density (pcf): ND
Optimum Moisture Content (%): ND

VI. Test Data:

Dry Density (pcf):	103.9
Initial Moisture Content (%):	18.7
Final Moisture Content (%):	23.4
Sample Length (cm):	5.16
Sample Area (cm^2):	42.08
Head (cm):	140.68
Quantity of Water Passing Through Sample (cm^3):	20.6
Elapsed Time (sec):	5340
Temperature (°F):	73
Viscosity Correction Factor:	0.931
Coefficient of Permeability -k (cm/sec):	3.1×10^{-6}

VII. Comments: Consolidated and tested at 2 psi head difference.

SUMMARY OF LABORATORY TESTING

R. J. REYNOLDS ASH MANAGEMENT AREA

GCI JOB NO: 93011
CONSTANT HEAD PERMEABILITY TEST
ASTM D 5084

I. Date of Test: June 7 - 11, 1993

II. Test Locations: B-11 (20.0' - 22.0')

III. Material Description: Tan Sandy SILT

IV. Material Condition: Undisturbed Tube Sample

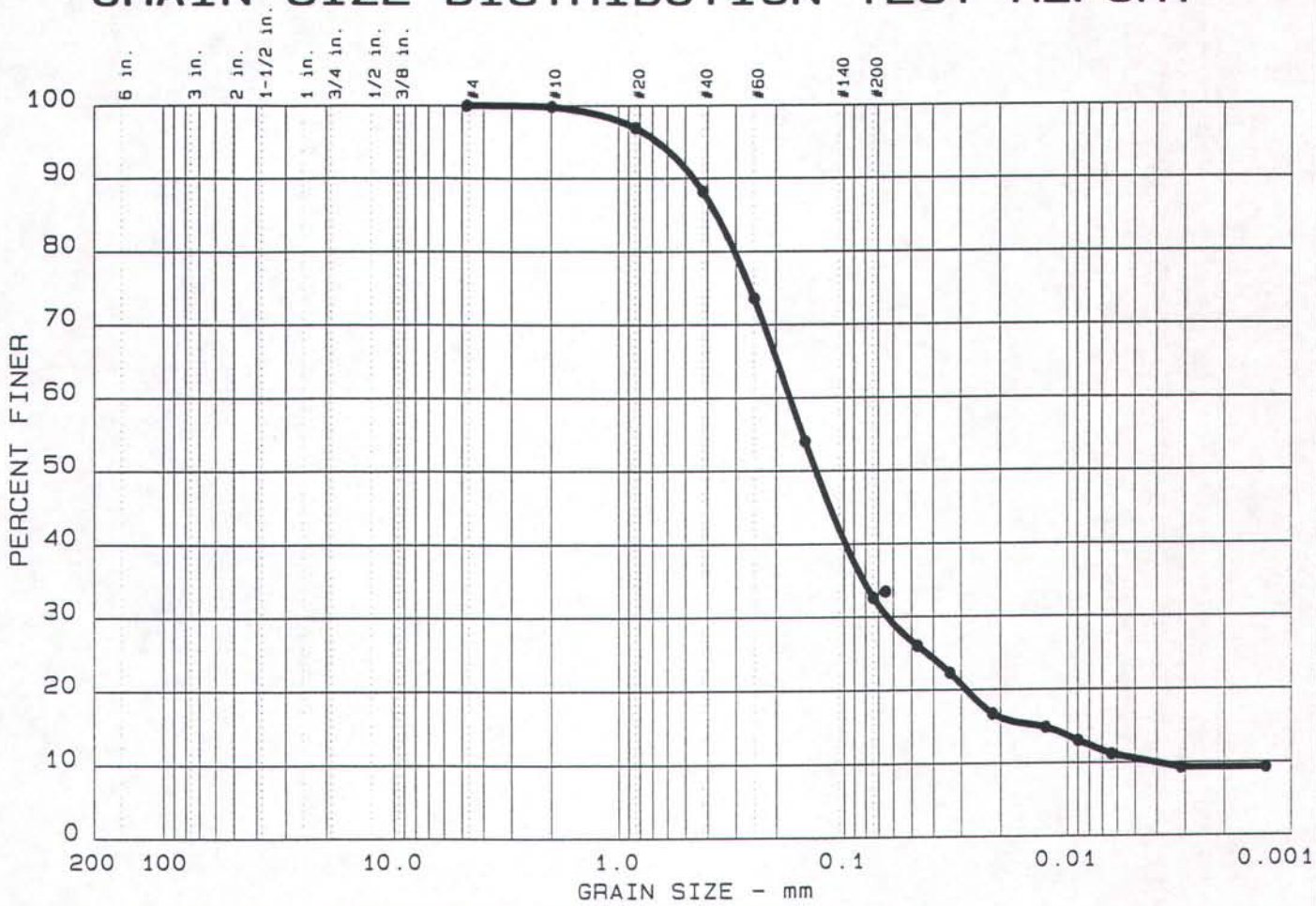
V. Proctor Data:
Maximum Dry Density (pcf): ND
Optimum Moisture Content (%): ND

VI. Test Data:

Dry Density (pcf):	77.2
Initial Moisture Content (%):	12.9
Final Moisture Content (%):	34.8
Sample Length (cm):	5.08
Sample Area (cm^2):	42.08
Head (cm):	140.68
Quantity of Water Passing Through Sample (cm^3):	108.9
Elapsed Time (sec):	240
Temperature (°F):	73
Viscosity Correction Factor:	0.931
Coefficient of Permeability -k (cm/sec):	3.6×10^{-4}

VII. Comments: Consolidated and tested at 2 psi head difference.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	67.4	22.1	10.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	0.36	0.17	0.13	0.064	0.0130	0.0040	5.82	43.2

MATERIAL DESCRIPTION	USCS	AASHTO
● Reddish Brown Clayey SILT	ND	ND

Project No.: 93011

Project: R. J. Reynolds Ash Management

● Location: B-9/2.3-4.3'

Date: 6-14-93

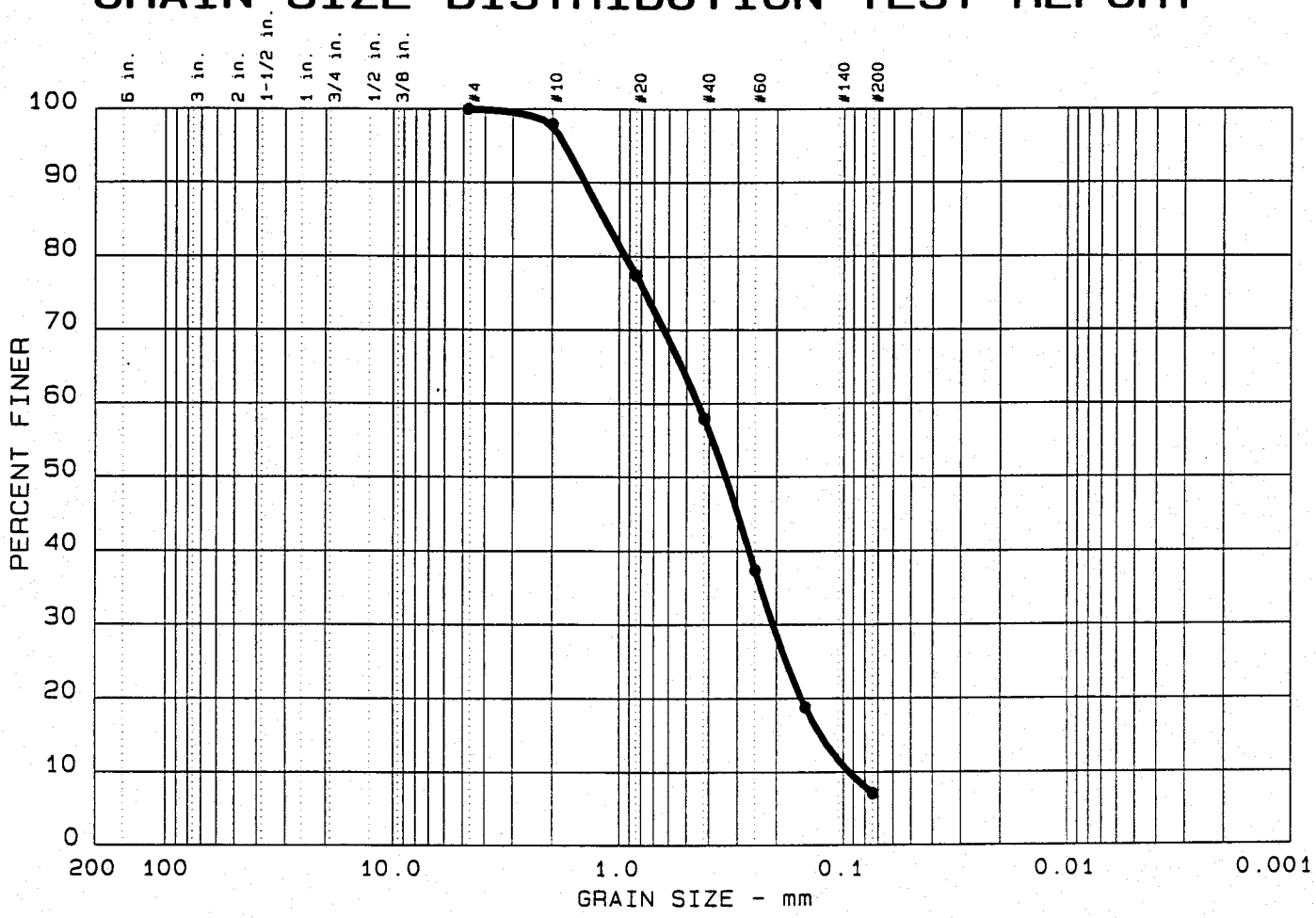
GRAIN SIZE DISTRIBUTION TEST REPORT

Remarks:

SPECIFIC GRAVITY=2.77

GEO-ENVIRONMENTAL CONSULTANTS, INC.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	92.9	7.1	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	1.16	0.45	0.34	0.208	0.1266	0.0939	1.03	4.8

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown Micaceous Silty SAND	ND	ND

Project No.: 93011
Project: R.J. Reynolds Ash Management Area
● Location: B-9/15.0-15.7'

Date: 6-14-93

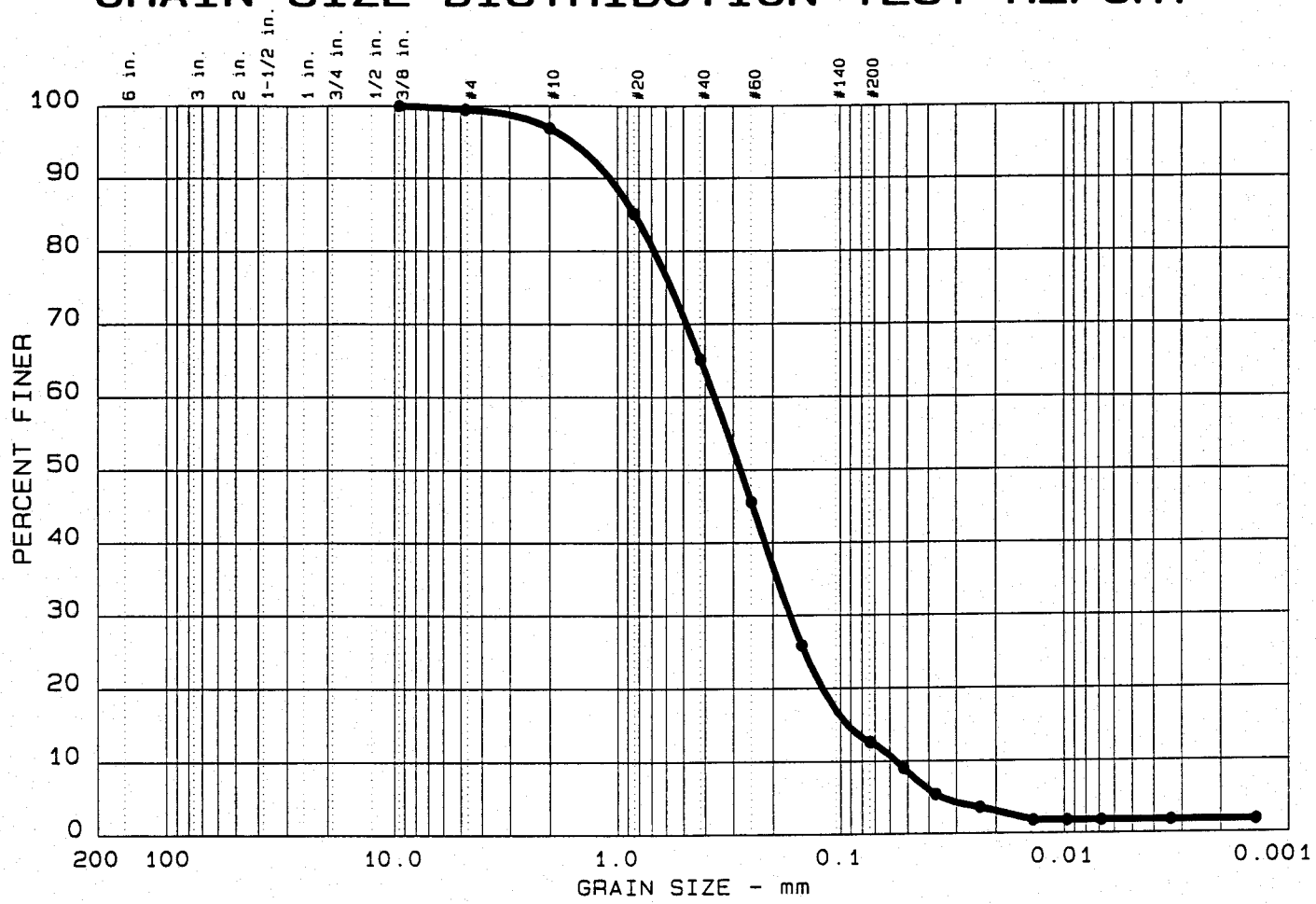
GRAIN SIZE DISTRIBUTION TEST REPORT

Remarks:

SPECIFIC GRAVITY=2.94

GEO-ENVIRONMENTAL CONSULTANTS, INC.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.5	86.8	10.9	1.8

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NP	NP	0.83	0.36	0.28	0.168	0.0933	0.0562	1.38	6.5

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown SILT with Little Mica	ND	ND

Project No.: 93011
Project: R. J. Reynolds Ash Management Area
● Location: B-11

Date: 6-14-93

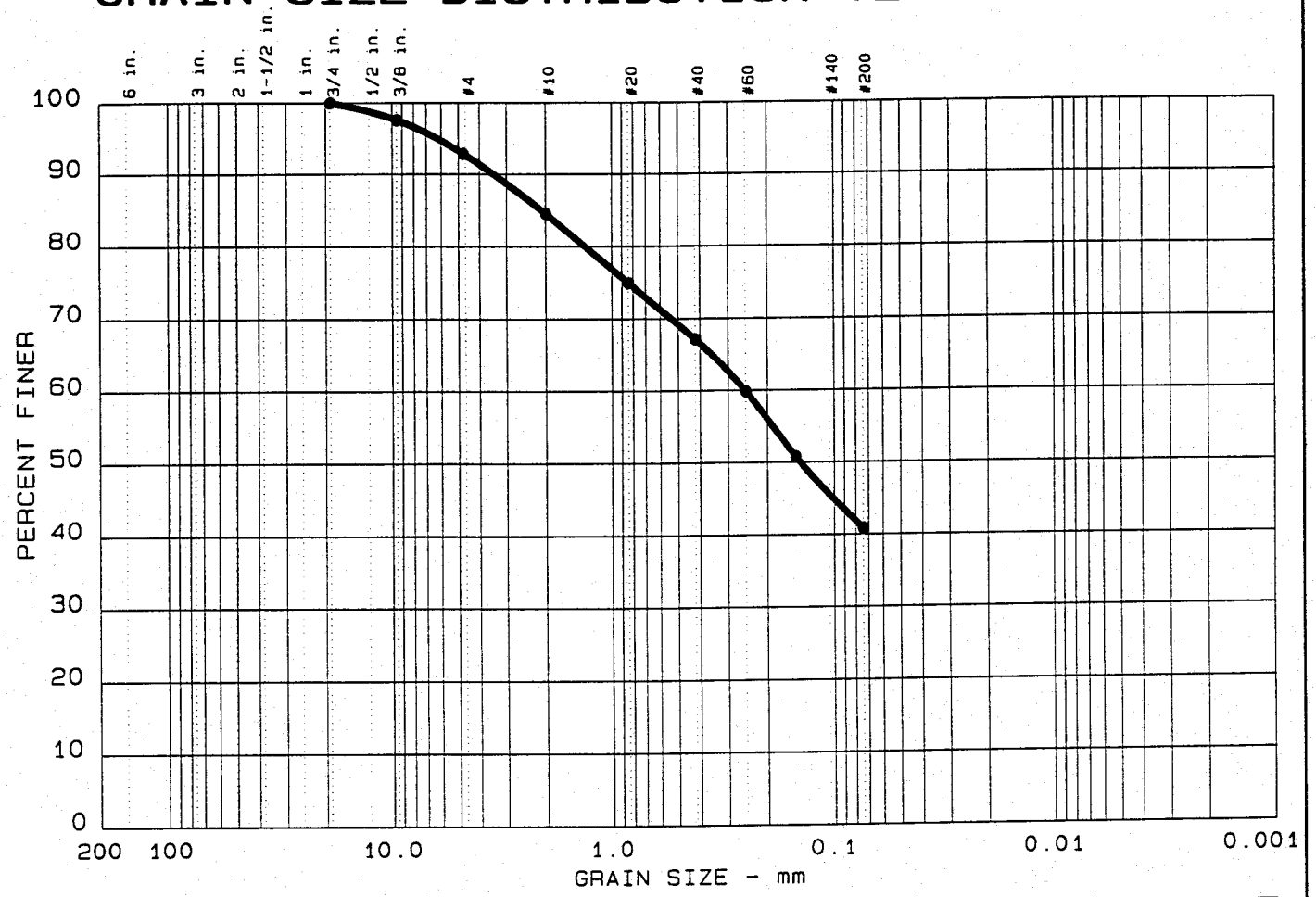
GRAIN SIZE DISTRIBUTION TEST REPORT

Remarks:

SPECIFIC GRAVITY=2.61

GEO-ENVIRONMENTAL CONSULTANTS, INC.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	7.1	52.1	40.8	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	38	15	2.07	0.25	0.14					

MATERIAL DESCRIPTION	USCS	AASHTO
● Reddish Brown Clayey SILT	ND	ND

Project No.: 93011

Project: R. J. Reynolds Ash Management Area

● Location: B-12/0.0-2.0'

Date: 6-14-93

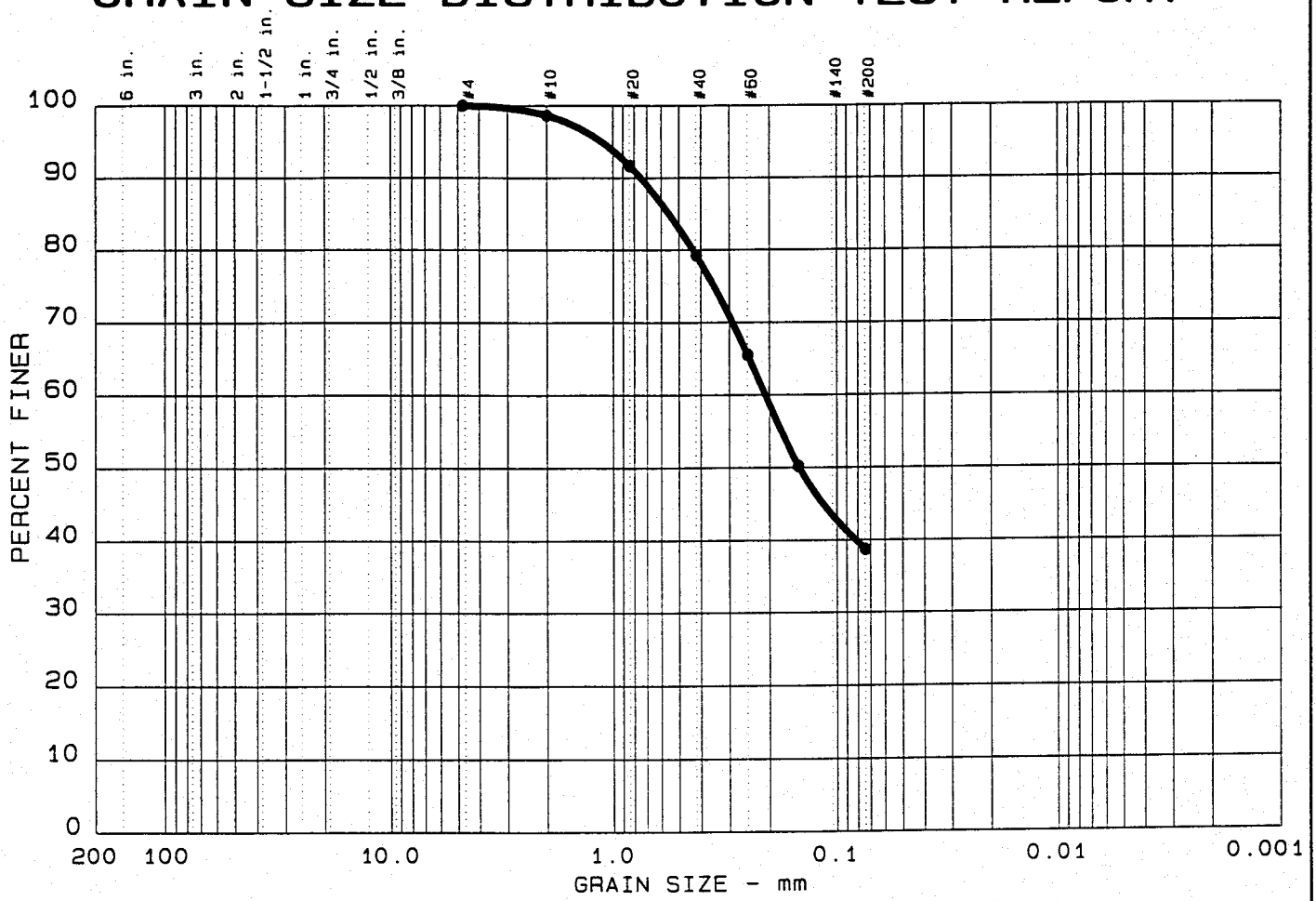
GRAIN SIZE DISTRIBUTION TEST REPORT

Remarks:

SPECIFIC GRAVITY=2.69

GEO-ENVIRONMENTAL CONSULTANTS, INC.

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	0.0	0.0	61.3	38.7	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	39	13	0.55	0.21	0.15					

MATERIAL DESCRIPTION	USCS	AASHTO
● Reddish Brown Clayey SILT	ND	ND

Project No.: 93011
Project: R. J. Reynolds Ash Management Area
● Location: B-13/1.0-2.0'

Date: 6-14-93

GRAIN SIZE DISTRIBUTION TEST REPORT

Remarks:

SPECIFIC GRAVITY=2.60

GEO-ENVIRONMENTAL CONSULTANTS, INC.

APPENDIX II

(Stormwater Management Calculations)

GEO-ENVIRONMENTAL CONSULTANTS, INC.

BY Chris Clauss DATE 6/28/93
CHKD. BY CDH DATE 10/11/93

RJR REYNOLDS - COAL ASH LANDFILL - FORSYTH COUNTY, NORTH CAROLINA
DRAINAGE DESIGN/ANALYSIS

REFER TO EXHIBIT A FOR DRAINAGE AREAS, SWALE LOCATIONS AND SEDIMENT BASINS
REFER TO EXHIBIT B FOR TYPICAL SWALE SECTIONS - GRASSED AND RIP RAP

BASIS FOR SWALE ANALYSIS:

NOTE: TRAPEZOIDAL CHANNELS TO BE USED FOR ALL PROPOSED SWALES

MANNINGS EQUATION TO BE USED FOR DESIGN: Q=(1.486/N)(Wp)**0.67(S)**0.5(AREA)

VARIABLE:
B = BOTTOM WIDTH OF CHANNEL (FEET)
Z = SIDE SLOPE OF CHANNEL (EG. 3 IS 3:1)
N = MANNINGS ROUGHNESS COEFFICIENT = .03 (UNCUT TALL FESCUE)
= .06 (CLASS B RIP RAP)
S = CHANNEL SLOPE (FEET PER FEET)
Y = FLOW DEPTH IN CHANNEL
AREA = FLOW AREA IN CHANNEL AT DEPTH Y
Wp = WETTED PERIMETER IN CHANNEL AT DEPTH Y
Qp = PEAK DISCHARGE IN CHANNEL (CUBIC FEET PER SECOND)
V1 = VELOCITY OF FLOW AT DEPTH Y USING MANNINGS EQUATION (FEET/SECOND)
V2 = VELOCITY OF FLOW AT DEPTH Y USING Qp=V(AREA)

FLOW DEPTH IS VARIED WITHIN THE CHANNELS UNTIL V1 = V2 = ACTUAL CHANNEL VELOCITY

I. SUB-AREA A

A. SWALE 1

DISCHARGE = Q(1A) = C(I)(A)
C = 0.4 (RURAL)
I = 5.7 INCHES/HR. (10 YR. EVENT)
A = AREAS A & B = 4.14 + 1.26 = 5.40 ACRES
Q(1A) = 12.3 CFS = Qp

NORTH CAROLINA PROFESSIONAL SEAL 18225 ENGINEER CHRISTOPHER D. HARDIN 10/11/93

ASSUMPTION: SWALE A DETAIL

B = 2 FT.
Z = 3 FT.
N = 0.03
S = 0.015 FT/FT
Qp = 12.3 CFS

Y	AREA	Wp	V1	V2	
0.15	0.3675	2.95	1.52	33.47	
0.3	0.87	3.90	2.24	14.14	
0.45	1.5075	4.85	2.79	8.16	
0.6	2.28	5.79	3.27	5.39	
0.75	3.1875	6.74	3.69	3.86	
0.77	3.3187	6.87	3.74	3.71	APPROX. VELOCITY AND DEPTH
1	5	8.32	4.33	2.46	
1.25	7.1875	9.91	4.91	1.71	
1.5	9.75	11.49	5.45	1.26	
1.75	12.6875	13.07	5.96	0.97	

V < 5 FPS AND Y < 1.0 FEET, THEREFORE SWALE A O.K.

GEO-ENVIRONMENTAL CONSULTANTS, INC.

BY Chris Chaves DATE 6/28/93

CHKD. BY CDH DATE 1/11/93

B. SWALE 2

DISCHARGE = Q(2A) = C(I)(A)
C = 0.4 (RURAL)
I = 5.7 INCHES/HR. (10 YR. EVENT)
A = AREA D = 0.33 ACRES
Q(2A) = 0.75 CFS = Qp

NORTH CAROLINA PROFESSIONAL SEAL 18225 ENGINEER CHRISTOPHER D. HARDIN 1/11/93

ASSUMPTION: SWALE A DETAIL

B = 2 FT.
Z = 3 FT.
N = 0.03
S = 0.04 FT/FT
Qp = 0.75 CFS

Y	AREA	Wp	V1	V2	
0.1	0.23	2.63	1.96	3.26	
0.12	0.2832	2.76	2.18	2.65	
0.125	0.296875	2.79	2.23	2.53	
0.13	0.3107	2.82	2.28	2.41	
0.135	0.324675	2.85	2.33	2.31	APPROX. VELOCITY AND DEPTH
0.5	1.75	5.16	4.83	0.43	
1	5	8.32	7.07	0.15	
1.25	7.1875	9.91	8.02	0.10	
1.5	9.75	11.49	8.90	0.08	

V < 5 FPS AND Y < 1.0 FEET, THEREFORE SWALE A O.K.

C. SWALE 3

DISCHARGE = Q(3A) = C(I)(A)
C = 0.4 (RURAL)
I = 5.7 INCHES/HR. (10 YR. EVENT)
A = AREA E = 0.18 ACRES
Q(3A) = 0.40 CFS = Qp

ASSUMPTION: SWALE A DETAIL

B = 2 FT.
Z = 3 FT.
N = 0.03
S = 0.04 FT/FT
Qp = 0.4 CFS

Y	AREA	Wp	V1	V2	
0.05	0.1075	2.32	1.28	3.72	
0.08	0.1792	2.51	1.71	2.23	
0.09	0.2043	2.57	1.84	1.96	
0.095	0.217075	2.60	1.90	1.84	APPROX. VELOCITY AND DEPTH
0.1	0.23	2.63	1.96	1.74	
0.5	1.75	5.16	4.83	0.23	
1	5	8.32	7.07	0.08	
1.25	7.1875	9.91	8.02	0.06	
1.5	9.75	11.49	8.90	0.04	

V < 5 FPS AND Y < 1.0 FEET, THEREFORE SWALE A O.K.

GEO-ENVIRONMENTAL CONSULTANTS, INC.

BY Chris Clearly DATE 6/28/93
CHKD. BY CDH DATE 10/11/93

D. SEDIMENT BASIN A

DISTURBED AREA TO BASIN = AREAS A,D,E, & F
=4.14 + .33 + .18 + 1.35 = 6.0 ACRES

REQUIRED STORAGE = 1800 CF/ACRE * 6.0 ACRES = 10,800 CF.

A 65' LONG x 45' WIDE x 4' HIGH BASIN PROVIDES 11,700 CF. OF STORAGE

DRAINAGE AREA TO BASIN = AREAS A,B,C,D,E,F & G
= 8.4 ACRES

DRAINAGE AREA < 50 ACRES, THEREFORE ROCK DAM O.K.

II. SUB-AREA B

A. SWALE 1

DISCHARGE = Q(1B) = C(I)(A) + Q(1A)
C = 0.4 (RURAL)
I = 5.7 INCHES/HR. (10 YR. EVENT)
A = AREAS H & M = 6.17 + 2.48 = 8.65 ACRES
Q(1B) = 32.0 CFS + 12.3 CFS = 44.3 CFS = Qp

NORTH CAROLINA PROFESSIONAL SEAL 18225 ENGINEER CHRISTOPHER D. HARDIN 10/11/93

ASSUMPTION: SWALE B DETAIL

B = 4.5 FT.
Z = 3 FT.
N = 0.03
S = 0.015 FT/FT
Qp = 44.3 CFS

Y	AREA	Wp	V1	V2	
0.5	3	7.66	3.26	14.77	
1	7.5	10.82	4.76	5.91	
1.1	8.58	11.46	5.02	5.16	
1.12	8.8032	11.58	5.07	5.03	APPROX. VELOCITY AND DEPTH
1.13	8.9157	11.65	5.09	4.97	
1.15	9.1425	11.77	5.14	4.85	
1	7.5	10.82	4.76	5.91	
1.25	10.3125	12.41	5.38	4.30	
1.5	13.5	13.99	5.94	3.28	
1.75	17.0625	15.57	6.47	2.60	

V = 5 FPS AND Y < 1.25 FEET, THEREFORE SWALE B O.K.

GEO-ENVIRONMENTAL CONSULTANTS, INC.

BY Chris Chuaco DATE 6/28/93
CHKD. BY CDH DATE 10/11/93

B. SWALE 2

DISCHARGE = Q(2B) = C(I)(A) + Q(2A)
C = 0.4 (RURAL)
I = 5.7 INCHES/HR. (10 YR. EVENT)
A = AREA I = 2.15 ACRES
Q(2B) = 4.90 CFS + 0.75 CFS = 5.65 = Qp

ASSUMPTION: SWALE C DETAIL

NORTH CAROLINA PROFESSIONAL SEAL 18225 ENGINEER CHRISTOPHER D. HARDIN 10/11/93

B = 1 FT.
Z = 3 FT.
N = 0.06
S = 0.08 FT/FT
Qp = 5.65 CFS

Y	AREA	Wp	V1	V2	
0.2	0.32	2.26	1.91	17.66	
0.3	0.57	2.90	2.38	9.91	
0.4	0.88	3.53	2.78	6.42	
0.5	1.25	4.16	3.15	4.52	
0.55	1.4575	4.48	3.32	3.88	
0.58	1.5892	4.67	3.42	3.56	
0.59	1.6343	4.73	3.46	3.46	APPROX. VELOCITY AND DEPTH
0.7	2.17	5.43	3.81	2.60	
1	4	7.32	4.69	1.41	

V < 25 FPS AND Y < 1.0 FEET, THEREFORE SWALE C O.K.

C. SWALE 3

DISCHARGE = Q(3B) = C(I)(A) + Q(3A) = Qp
C = 0.4 (RURAL)
I = 5.7 INCHES/HR. (10 YR. EVENT)
A = AREA N = 0.36 ACRES
Q(3B) = 0.82 CFS + 0.40 CFS = 1.22 CFS = Qp

ASSUMPTION: SWALE A DETAIL

B = 2 FT.
Z = 3 FT.
N = 0.03
S = 0.08 FT/FT
Qp = 1.22 CFS

Y	AREA	Wp	V1	V2	
0.1	0.23	2.63	2.77	5.30	
0.12	0.2832	2.76	3.08	4.31	
0.13	0.3107	2.82	3.23	3.93	
0.14	0.3388	2.89	3.37	3.60	APPROX. VELOCITY AND DEPTH
0.15	0.3675	2.95	3.50	3.32	
0.2	0.52	3.26	4.13	2.35	
0.5	1.75	5.16	6.83	0.70	
1	5	8.32	10.00	0.24	
1.5	9.75	11.49	12.59	0.13	

V < 5 FPS AND Y < 1.0 FEET, THEREFORE SWALE A O.K.

GEO-ENVIRONMENTAL CONSULTANTS, INC.

BY Chris Clements DATE 6/28/93
CHKD. BY CDH DATE 10/11/93

D. SEDIMENT BASIN B

DISTURBED AREA TO BASIN = AREAS H,I,J & N
=6.17 + 2.15 + 3.54 + 0.36 = 12.22 ACRES

REQUIRED STORAGE = 1800 CF/ACRE * 6.0 ACRES = 21,996 CF.

A 100' LONG x 60' WIDE x 4' HIGH BASIN PROVIDES 24,000 CF. OF STORAGE

DRAINAGE AREA TO BASIN = AREAS A,B,D,E,H,I,J,K,L,M & N
= 22.70 ACRES

DRAINAGE AREA < 50 ACRES, THEREFORE ROCK DAM O.K.

III. SUB-AREA C

A. SWALE 1

DISCHARGE = Q(1C) = C(I)(A) + Q(1B)
C = 0.4 (RURAL)
I = 5.7 INCHES/HR. (10 YR. EVENT)
A = AREAS Q,O,R & W = 5.78 + 2.24 + 8.14 + 0.59 = 16.75 ACRES
Q(1C) = 38.2 CFS + 44.3 CFS = 82.5 CFS = Qp

ASSUMPTION: SWALE D DETAIL

B = 2 FT.
Z = 3 FT.
N = 0.06
S = 0.12 FT/FT
Qp = 82.5 CFS

NORTH CAROLINA PROFESSIONAL SEAL 8225 ENGINEER CHRISTOPHER D. HARDIN

Y	AREA	Wp	V1	V2	
0.5	1.75	5.16	4.18	47.14	
1	5	8.32	6.12	16.50	
1.25	7.1875	9.91	6.95	11.48	
1.5	9.75	11.49	7.71	8.46	
1.55	10.3075	11.80	7.86	8.00	
1.56	10.4208	11.87	7.89	7.92	APPROX. VELOCITY AND DEPTH
1.6	10.88	12.12	8.01	7.58	
1.75	12.6875	13.07	8.43	6.50	
2	16	14.65	9.12	5.16	
2.25	19.6875	16.23	9.78	4.19	

V < 25 FPS AND Y < 1.67 FEET, THEREFORE SWALE D O.K.

GEO-ENVIRONMENTAL CONSULTANTS, INC.

BY Chris Closser DATE 6/28/93
CHKD. BY CDH DATE 6/11/93

B. SWALE 3

DISCHARGE = Q(3C) = C(I)(A) + Q(3B)
C = 0.4 (RURAL)
I = 5.7 INCHES/HR. (10 YR. EVENT)
A = AREA U = 0.30 ACRES
Q(3C) = 0.68 CFS + 1.22 CFS = 1.90 CFS = Qp

ASSUMPTION: SWALE A DETAIL

B = 2 FT.
Z = 3 FT.
N = 0.03
S = 0.017 FT/FT
Qp = 1.9 CFS

Y	AREA	Wp	V1	V2	
0.2	0.52	3.26	1.90	3.65	
0.22	0.5852	3.39	2.01	3.25	
0.24	0.6528	3.52	2.11	2.91	
0.27	0.7587	3.71	2.25	2.50	
0.28	0.7952	3.77	2.29	2.39	
0.29	0.8323	3.83	2.34	2.28	APPROX. VELOCITY AND DEPTH
0.35	1.0675	4.21	2.59	1.78	
0.5	1.75	5.16	3.15	1.09	
1	5	8.32	4.61	0.38	

V < 5 FPS AND Y < 1.0 FEET, THEREFORE SWALE A O.K.

C. SWALE 2

DISCHARGE = Q(2C) = C(I)(A) + Q(2B) + Q(3C) = Qp
C = 0.4 (RURAL)
I = 5.7 INCHES/HR. (10 YR. EVENT)
A = AREA P & V = 5.32 + 0.79 = 6.11 ACRES
Q(2C) = 13.93 + 5.65 + 1.90 = 21.48 CFS = Qp

NORTH CAROLINA PROFESSIONAL SEAL 18225 ENGINEER CHRISTOPHER D. HARDIN

ASSUMPTION: SWALE A DETAIL

B = 2 FT.
Z = 3 FT.
N = 0.03
S = 0.018 FT/FT
Qp = 21.48 CFS

Y	AREA	Wp	V1	V2	
0.25	0.6875	3.58	2.22	31.24	
0.5	1.75	5.16	3.24	12.27	
0.75	3.1875	6.74	4.04	6.74	
0.95	4.6075	8.01	4.61	4.66	APPROX. VELOCITY AND DEPTH
1	5	8.32	4.74	4.30	
1.5	9.75	11.49	5.97	2.20	
1.75	12.6875	13.07	6.53	1.69	
1	5	8.32	4.74	4.30	
1.5	9.75	11.49	5.97	2.20	

V < 5 FPS AND Y < 1.0 FEET, THEREFORE SWALE A O.K.

GEO-ENVIRONMENTAL CONSULTANTS, INC.

BY Chris Clemmer DATE 6/28/93
CHKD. BY CDH DATE 10/11/93

D. SEDIMENT BASIN C

DISTURBED AREA TO BASIN = AREAS O,P,Q & U
= 2.24 + 5.32 + 5.78 + 0.30 = 13.64 ACRES

REQUIRED STORAGE = 1800 CF/ACRE * 13.64 ACRES = 24,552 CF.

A 100' LONG x 65' WIDE x 4' HIGH BASIN PROVIDES 26,000 CF. OF STORAGE

DRAINAGE AREA TO BASIN = AREAS A,B,D,E,H,I,M,N,O,P,Q,R,S,U,V & W
= 42.00 ACRES

DRAINAGE AREA < 50 ACRES, THEREFORE ROCK DAM O.K.

IV. STORM WATER BASIN

DRAINAGE AREA TO BASIN = AREAS A,B,D,E,H,I,M,N,O,P,Q,R,S,U,V,W & T
= 43.34 ACRES

DISCHARGE = Q(TOTAL) = C(I)(A)
C = 0.4 (RURAL)
I = 5.7 INCHES/HR. (10 YR. EVENT)
A = 43.34 ACRES
Q(TOTAL) = 98.81 CFS

NORTH CAROLINA PROFESSIONAL SEAL 18225 ENGINEER CHRISTOPHER D. HARDIN

BASIN SIZE = 100' LONG x 65' WIDE x 6' HIGH = 39,000 CY.

BOTTOM OF BASIN ELEVATION = 825.0

TOP OF DAM ELEVATION = 832.50

PRIMARY OUTLET IS 36" C.M.P. RISER WITH 30" C.M.P. OUTLET CONDUIT
PRIMARY OUTLET ELEVATION = 830.00

SECONDARY OUTLET IS A 20' WIDE STONE WEIR IN CUT (CLASS B STONE)
SECONDARY OUTLET ELEVATION = 831.00

BASIN DISCHARGE AT WATER ELEVATION = 832.0 = Q(MAX)
Q(MAX) = Q(PRIMARY) + Q(SECONDARY)
Q(PRIMARY) = 3.1(9.42)(832.0-830.0)**1.5 = 82.6 CFS = Q(36" RISER)
= .6((2)(32.2)(832.0-826.0))**0.5(4.90) = 57.8 CFS. = Q(30" CONDUIT)
Q(PRIMARY) = Q(30" CONDUIT) = 57.8 CFS = CONTROLLING DISCHARGE
Q(SECONDARY) = 2.87(20')(832.0-831.0)**1.5 = 57.40 CFS.
Q(MAX) = 57.8 + 57.4 = 115.2 CFS.

SINCE Q(MAX) > Q(TOTAL), BASIN DESIGN O.K.

15' LONG x 10' WIDE CLASS B RIP RAP APRON PROVIDED AT CONDUIT OUTLET

ANTI-FLOTATION BLOCK = 1.1 TIMES WEIGHT OF WATER DISPLACED BY EMPTY RISER = W
W = 7.07(5)(62.4)(1.1) = 2,426 lb.
A 5' SQUARE FOOTING 1' DEEP PROVIDES 2,500 lb. OF ANCHORAGE > 2,426 lb., O.K.

GEO-ENVIRONMENTAL
CONSULTANTS, INC.

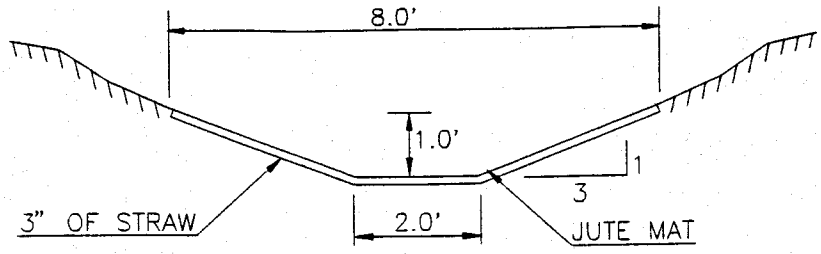
BY Chris Hardin DATE 6/28/93
CHKD. BY CDH DATE 10/11/93

V. STORM DRAINAGE PIPE DESIGN

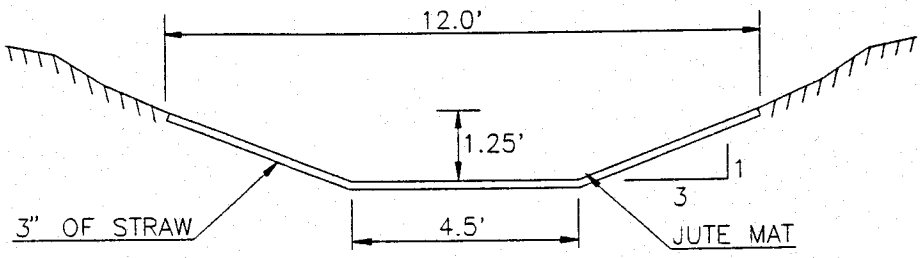
DISCHARGE TO PIPE = Q = Q(2C) = 21.48 CFS.
TRIAL: 24" N-12 @ 20.50%
Q(FULL) = 110.7 CFS. = MANNING'S EQUATION
Q(INLET) = 0.6((2)(32.2)(9))**0.5(3.14) = 45.35 CFS. = CONTROLLING CONDITION
Q(INLET) > Q(2C), THEREFORE 24" PIPE O.K.

CLASS B RIP RAP APRON PROVIDED AT PIPE OUTLET AND INTERSECTION OF SWALES.
APRON DIMENSIONS = 40' x 40' (APPROXIMATELY)

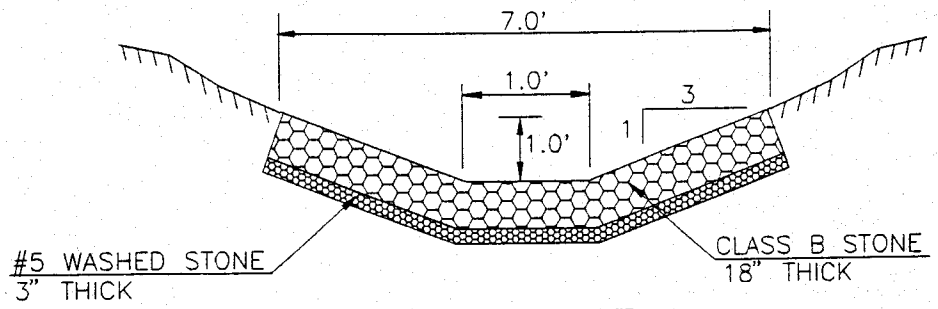
NORTH CAROLINA PROFESSIONAL SEAL 18225 ENGINEER CHRISTOPHER D. HARDIN



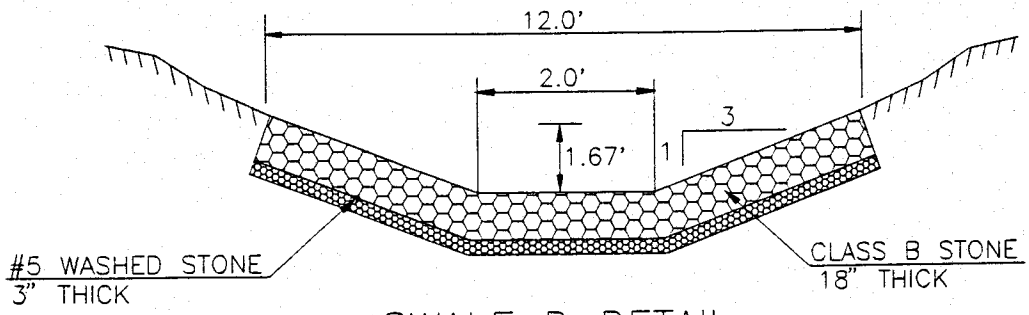
SWALE A DETAIL



SWALE B DETAIL



SWALE C DETAIL



SWALE D DETAIL

GCI

R.J. REYNOLDS TOBACCO CO.
COAL ASH MANAGEMENT AREA
FORSYTH COUNTY, NORTH CAROLINA

SWALE DETAILS

PROJECT #: 93011	DATE:	PROJECT MGR: C.D.H.
		DESIGN BY: N.A.
		DRAWN BY: C.N.I.
		SCALE: 1" = 60'
		EXHIBIT B

GEO-ENVIRONMENTAL CONSULTANTS, INC.
GEOTECHNICAL/ENVIRONMENTAL ENGINEERS & SCIENTISTS
1016 McCLELLAND COURT, CHARLOTTE, NC 28206
PHONE (704)332-2060 FAX (704)334-0405

APPENDIX III

(Chemical Analysis and Computer Model Output)

(MULTIMED COMPUTER ANALYSIS)

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

SELENIUM - TRIAL NO. 1A

DISTANCE FROM WELL: 1200 (FT)

DEFAULT

CASE
Chemical simulated is SELENIUM

Option Chosen	Saturated and unsaturated zone models
Run was	DETERMIN

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Do not reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)

NP	-	Total number of nodal points	240
NMAT	-	Number of different porous materials	3
KPROP	-	Van Genuchten or Brooks and Corey	1
IMSHGN	-	Spatial discretization option	1
NVFLAYR	-	Number of layers in flow model	3

OPTIONS CHOSEN

Van Genuchten functional coefficients
User defined coordinate system

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	3.10	1
2	1.20	2
3	3.10	3

DATA FOR MATERIAL 1

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.220E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.420	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.100E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.23	-999.	1.00	5.00

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.460	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.670E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	-	Number of different layers used	3
NTSTPS	-	Number of time values concentration calc	40
DUMMY	-	Not presently used	1
ISOL	-	Type of scheme used in unsaturated zone	1
N	-	Stehfest terms or number of increments	18
NTEL	-	Points in Lagrangian interpolation	3
NGPTS	-	Number of Gauss points	104
NIT	-	Convolution integral segments	2
IBOUND	-	Type of boundary condition	1
ITSGEN	-	Time values generated or input	1
TMAX	-	Max simulation time --	0.0
WTFUN	-	Weighing factor --	1.2

OPTIONS CHOSEN

Stehfest numerical inversion algorithm
Nondecaying continuous source
Computer generated times for computing concentrations

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer		DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.49	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	1.20	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.38	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	25.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	25.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry's law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.100E-03	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.388E+05	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.100E-03	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	0.500E-01	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	210.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	185.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.100E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	100.	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	0.540E-01	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.500E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	CONSTANT	10.0	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	13.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.50	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.310E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	365.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	5.00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.100E-01	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.2590E-11 mg/l.

U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

SELENIUM - TRIAL NO. 2A

DISTANCE FROM WELL: 500 (FT)

DEFAULT

CASE
Chemical simulated is SELENIUM

Option Chosen	Saturated and unsaturated zone models
Run was	DETERMIN

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Do not reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)

NP	-	Total number of nodal points	240
NMAT	-	Number of different porous materials	3
KPROP	-	Van Genuchten or Brooks and Corey	1
IMSHGN	-	Spatial discretization option	1
NVFLAYR	-	Number of layers in flow model	3

OPTIONS CHOSEN

Van Genuchten functional coefficients
User defined coordinate system

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	3.10	1
2	1.20	2
3	3.10	3

DATA FOR MATERIAL 1

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.220E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.420	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.100E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.23	-999.	1.00	5.00

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.460	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.670E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	-	Number of different layers used	3
NTSTPS	-	Number of time values concentration calc	40
DUMMY	-	Not presently used	1
ISOL	-	Type of scheme used in unsaturated zone	1
N	-	Stehfest terms or number of increments	18
NTEL	-	Points in Lagrangian interpolation	3
NGPTS	-	Number of Gauss points	104
NIT	-	Convolution integral segments	2
IBOUND	-	Type of boundary condition	1
ITSGEN	-	Time values generated or input	1
TMAX	-	Max simulation time --	0.0
WTFUN	-	Weighing factor --	1.2

OPTIONS CHOSEN

Stehfest numerical inversion algorithm
Nondecaying continuous source
Computer generated times for computing concentrations

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer		DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.49	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	1.20	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.38	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	25.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	25.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry's law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.100E-03	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.388E+05	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.100E-03	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	0.500E-01	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	210.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	185.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.100E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	100.	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	0.540E-01	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.500E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	CONSTANT	10.0	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	13.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.50	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.310E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	152.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	5.00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.100E-01	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.6093E-05 mg/l.

U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

SELENIUM - TRIAL NO. 3A

DISTANCE FROM WELL: 100 (FT)

DEFAULT

CASE
Chemical simulated is SELENIUM

Option Chosen	Saturated and unsaturated zone models
Run was	DETERMIN

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Do not reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)

NP	-	Total number of nodal points	240
NMAT	-	Number of different porous materials	3
KPROP	-	Van Genuchten or Brooks and Corey	1
IMSHGN	-	Spatial discretization option	1
NVFLAYR	-	Number of layers in flow model	3

OPTIONS CHOSEN

Van Genuchten functional coefficients
User defined coordinate system

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	3.10	1
2	1.20	2
3	3.10	3

DATA FOR MATERIAL 1

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.220E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.420	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.100E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.23	-999.	1.00	5.00

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.460	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.670E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	-	Number of different layers used	3
NTSTPS	-	Number of time values concentration calc	40
DUMMY	-	Not presently used	1
ISOL	-	Type of scheme used in unsaturated zone	1
N	-	Stehfest terms or number of increments	18
NTEL	-	Points in Lagrangian interpolation	3
NGPTS	-	Number of Gauss points	104
NIT	-	Convolution integral segments	2
IBOUND	-	Type of boundary condition	1
ITSGEN	-	Time values generated or input	1
TMAX	-	Max simulation time --	0.0
WTFUN	-	Weighing factor --	1.2

OPTIONS CHOSEN

Stehfest numerical inversion algorithm
Nondecaying continuous source
Computer generated times for computing concentrations

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer		DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.49	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	1.20	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.38	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	25.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	25.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry's law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.100E-03	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.388E+05	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.100E-03	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	0.500E-01	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	210.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	185.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.100E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	100.	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	0.540E-01	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.500E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	CONSTANT	10.0	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	13.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.50	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.310E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	30.5	-999.	1.00	-999.
Angle off center	degree	CONSTANT	5.00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.100E-01	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.2363E-02 mg/l.

U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

CHROMIUM - TRIAL NO. 1B

DISTANCE FROM WELL: 1200 (FT)

DEFAULT

CASE
Chemical simulated is CHROMIUM

Option Chosen	Saturated and unsaturated zone models
Run was	DETERMIN
Infiltration input by user	
Run was steady-state	
Reject runs if Y coordinate outside plume	
Do not reject runs if Z coordinate outside plume	
Gaussian source used in saturated zone model	

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)

NP	-	Total number of nodal points	240
NMAT	-	Number of different porous materials	3
KPROP	-	Van Genuchten or Brooks and Corey	1
IMSHGN	-	Spatial discretization option	1
NVFLAYR	-	Number of layers in flow model	3

OPTIONS CHOSEN

Van Genuchten functional coefficients
User defined coordinate system

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	3.10	1
2	1.20	2
3	3.10	3

DATA FOR MATERIAL 1

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.220E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.420	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.100E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.23	-999.	1.00	5.00

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.460	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.670E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	-	Number of different layers used	3
NTSTPS	-	Number of time values concentration calc	40
DUMMY	-	Not presently used	1
ISOL	-	Type of scheme used in unsaturated zone	1
N	-	Stehfest terms or number of increments	18
NTEL	-	Points in Lagrangian interpolation	3
NGPTS	-	Number of Gauss points	104
NIT	-	Convolution integral segments	2
IBOUND	-	Type of boundary condition	1
ITSGEN	-	Time values generated or input	1
TMAX	-	Max simulation time --	0.0
WTFUN	-	Weighing factor --	1.2

OPTIONS CHOSEN

Stehfest numerical inversion algorithm
Nondecaying continuous source
Computer generated times for computing concentrations

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer		DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.49	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	1.20	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.38	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	25.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	25.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry's law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

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VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.100E-03	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.388E+05	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.100E-03	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	0.840E-01	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	210.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	185.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.100E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	100.	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	0.540E-01	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.500E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	CONSTANT	10.0	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	13.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.50	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.310E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	365.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	5.00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.100E-01	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.4352E-11 mg/l.

U. S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

CHROMIUM - TRIAL NO. 2B

DISTANCE FROM WELL: 500 (FT)

DEFAULT

CASE
Chemical simulated is CHROMIUM

Option Chosen	Saturated and unsaturated zone models
Run was	DETERMIN
Infiltration input by user	
Run was steady-state	
Reject runs if Y coordinate outside plume	
Do not reject runs if Z coordinate outside plume	
Gaussian source used in saturated zone model	

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)

NP	-	Total number of nodal points	240
NMAT	-	Number of different porous materials	3
KPROP	-	Van Genuchten or Brooks and Corey	1
IMSHGN	-	Spatial discretization option	1
NVFLAYR	-	Number of layers in flow model	3

OPTIONS CHOSEN

Van Genuchten functional coefficients
User defined coordinate system

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	3.10	1
2	1.20	2
3	3.10	3

DATA FOR MATERIAL 1

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.220E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.420	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.100E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.23	-999.	1.00	5.00

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.460	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.670E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	-	Number of different layers used	3
NTSTPS	-	Number of time values concentration calc	40
DUMMY	-	Not presently used	1
ISOL	-	Type of scheme used in unsaturated zone	1
N	-	Stehfest terms or number of increments	18
NTEL	-	Points in Lagrangian interpolation	3
NGPTS	-	Number of Gauss points	104
NIT	-	Convolution integral segments	2
IBOUND	-	Type of boundary condition	1
ITSGEN	-	Time values generated or input	1
TMAX	-	Max simulation time --	0.0
WTFUN	-	Weighing factor --	1.2

OPTIONS CHOSEN

Stehfest numerical inversion algorithm
Nondecaying continuous source
Computer generated times for computing concentrations

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer		DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.49	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	1.20	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.38	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	25.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	25.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry's law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.100E-03	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.388E+05	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.100E-03	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	0.840E-01	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	210.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	185.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.100E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	100.	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	0.540E-01	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.500E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	CONSTANT	10.0	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	13.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.50	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.310E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	152.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	5.00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.100E-01	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.1024E-04 mg/l.

U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

CHROMIUM - TRIAL NO. 3B

DISTANCE FROM WELL: 100 (FT)

DEFAULT

CASE
Chemical simulated is CHROMIUM

Option Chosen	Saturated and unsaturated zone models
Run was	DETERMIN
Infiltration input by user	
Run was steady-state	
Reject runs if Y coordinate outside plume	
Do not reject runs if Z coordinate outside plume	
Gaussian source used in saturated zone model	

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)

NP	-	Total number of nodal points	240
NMAT	-	Number of different porous materials	3
KPROP	-	Van Genuchten or Brooks and Corey	1
IMSHGN	-	Spatial discretization option	1
NVFLAYR	-	Number of layers in flow model	3

OPTIONS CHOSEN

Van Genuchten functional coefficients
User defined coordinate system

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	3.10	1
2	1.20	2
3	3.10	3

DATA FOR MATERIAL 1

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.220E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.420	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.100E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.23	-999.	1.00	5.00

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.460	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.670E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	-	Number of different layers used	3
NTSTPS	-	Number of time values concentration calc	40
DUMMY	-	Not presently used	1
ISOL	-	Type of scheme used in unsaturated zone	1
N	-	Stehfest terms or number of increments	18
NTEL	-	Points in Lagrangian interpolation	3
NGPTS	-	Number of Gauss points	104
NIT	-	Convolution integral segments	2
IBOUND	-	Type of boundary condition	1
ITSGEN	-	Time values generated or input	1
TMAX	-	Max simulation time --	0.0
WTFUN	-	Weighing factor --	1.2

OPTIONS CHOSEN

Stehfest numerical inversion algorithm
Nondecaying continuous source
Computer generated times for computing concentrations

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer		DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.49	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	1.20	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.38	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	25.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	25.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry's law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.100E-03	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.388E+05	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.100E-03	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	0.840E-01	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	210.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	185.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.100E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	100.	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	0.540E-01	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.500E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	CONSTANT	10.0	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	13.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.50	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.310E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	30.5	-999.	1.00	-999.
Angle off center	degree	CONSTANT	5.00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.100E-01	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.3970E-02 mg/l.

U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

BARIUM - TRIAL NO. 1C

DISTANCE FROM WELL: 1200 (FT)

DEFAULT

CASE
Chemical simulated is BARIUM

Option Chosen	Saturated and unsaturated zone models
Run was	DETERMIN

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Do not reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)

NP	-	Total number of nodal points	240
NMAT	-	Number of different porous materials	3
KPROP	-	Van Genuchten or Brooks and Corey	1
IMSHGN	-	Spatial discretization option	1
NVFLAYR	-	Number of layers in flow model	3

OPTIONS CHOSEN

Van Genuchten functional coefficients
User defined coordinate system

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	3.10	1
2	1.20	2
3	3.10	3

DATA FOR MATERIAL 1

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.220E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.420	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.100E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.23	-999.	1.00	5.00

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.460	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.670E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	-	Number of different layers used	3
NTSTPS	-	Number of time values concentration calc	40
DUMMY	-	Not presently used	1
ISOL	-	Type of scheme used in unsaturated zone	1
N	-	Stehfest terms or number of increments	18
NTEL	-	Points in Lagrangian interpolation	3
NGPTS	-	Number of Gauss points	104
NIT	-	Convolution integral segments	2
IBOUND	-	Type of boundary condition	1
ITSGEN	-	Time values generated or input	1
TMAX	-	Max simulation time --	0.0
WTFUN	-	Weighing factor --	1.2

OPTIONS CHOSEN

Stehfest numerical inversion algorithm
Nondecaying continuous source
Computer generated times for computing concentrations

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer		DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.49	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	1.20	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.38	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	25.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	25.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry's law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

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VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.100E-03	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.388E+05	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.100E-03	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	0.660	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	210.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	185.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.100E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	100.	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	0.540E-01	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.500E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	CONSTANT	10.0	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	13.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.50	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.310E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	365.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	5.00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.100E-01	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.3419E-10 mg/l.

U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

BARIUM - TRIAL NO. 2C

DISTANCE FROM WELL: 500 (FT)

DEFAULT

CASE
Chemical simulated is BARIUM

Option Chosen	Saturated and unsaturated zone models
Run was	DETERMIN
Infiltration input by user	
Run was steady-state	
Reject runs if Y coordinate outside plume	
Do not reject runs if Z coordinate outside plume	
Gaussian source used in saturated zone model	

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)

NP	-	Total number of nodal points	240
NMAT	-	Number of different porous materials	3
KPROP	-	Van Genuchten or Brooks and Corey	1
IMSHGN	-	Spatial discretization option	1
NVFLAYR	-	Number of layers in flow model	3

OPTIONS CHOSEN

Van Genuchten functional coefficients
User defined coordinate system

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	3.10	1
2	1.20	2
3	3.10	3

DATA FOR MATERIAL 1

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.220E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.420	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.100E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.23	-999.	1.00	5.00

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.460	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.670E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	-	Number of different layers used	3
NTSTPS	-	Number of time values concentration calc	40
DUMMY	-	Not presently used	1
ISOL	-	Type of scheme used in unsaturated zone	1
N	-	Stehfest terms or number of increments	18
NTEL	-	Points in Lagrangian interpolation	3
NGPTS	-	Number of Gauss points	104
NIT	-	Convolution integral segments	2
IBOUND	-	Type of boundary condition	1
ITSGEN	-	Time values generated or input	1
TMAX	-	Max simulation time --	0.0
WTFUN	-	Weighing factor --	1.2

OPTIONS CHOSEN

Stehfest numerical inversion algorithm
Nondecaying continuous source
Computer generated times for computing concentrations

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer		DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.49	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	1.20	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.38	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	1/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	25.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	25.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry's law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.100E-03	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.388E+05	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.100E-03	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	0.660	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	210.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	185.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.100E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	100.	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	0.540E-01	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.500E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	CONSTANT	10.0	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	13.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.50	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.310E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	152.	-999.	1.00	-999.
Angle off center	degree	CONSTANT	5.00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.100E-01	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.8043E-04 mg/l.

U.S. ENVIRONMENTAL PROTECTION AGENCY

EXPOSURE ASSESSMENT

MULTIMEDIA MODEL

MULTIMED (Version 1.01, June 1991)

BARIUM - TRIAL NO. 3C

DISTANCE FROM WELL: 100 (FT)

DEFAULT

CASE
Chemical simulated is BARIUM

Option Chosen	Saturated and unsaturated zone models
Run was	DETERMIN

Infiltration input by user
Run was steady-state
Reject runs if Y coordinate outside plume
Do not reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model

UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)

NP	-	Total number of nodal points	240
NMAT	-	Number of different porous materials	3
KPROP	-	Van Genuchten or Brooks and Corey	1
IMSHGN	-	Spatial discretization option	1
NVFLAYR	-	Number of layers in flow model	3

OPTIONS CHOSEN

Van Genuchten functional coefficients
User defined coordinate system

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	3.10	1
2	1.20	2
3	3.10	3

DATA FOR MATERIAL 1

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.220E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.420	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.100E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.23	-999.	1.00	5.00

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.460	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.670E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.540E-01	-999.	0.100E-10	0.100E+05
Unsaturated zone porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Air entry pressure head	m	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Depth of the unsaturated zone	m	CONSTANT	7.40	-999.	0.100E-08	-999.

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Residual water content	--	CONSTANT	0.890E-01	-999.	0.100E-08	1.00
Brook and Corey exponent,EN	--	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
ALFA coefficient	1/cm	CONSTANT	0.200E-01	-999.	0.000E+00	1.00
Van Genuchten exponent, ENN	--	CONSTANT	1.41	-999.	1.00	5.00

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	-	Number of different layers used	3
NTSTPS	-	Number of time values concentration calc	40
DUMMY	-	Not presently used	1
ISOL	-	Type of scheme used in unsaturated zone	1
N	-	Stehfest terms or number of increments	18
NTEL	-	Points in Lagrangian interpolation	3
NGPTS	-	Number of Gauss points	104
NIT	-	Convolution integral segments	2
IBOUND	-	Type of boundary condition	1
ITSGEN	-	Time values generated or input	1
TMAX	-	Max simulation time --	0.0
WTFUN	-	Weighing factor --	1.2

OPTIONS CHOSEN

Stehfest numerical inversion algorithm
Nondecaying continuous source
Computer generated times for computing concentrations

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer		DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.49	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	1.20	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.38	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Thickness of layer	m	CONSTANT	3.10	-999.	0.100E-08	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	0.100E-02	0.100E+05
Percent organic matter	--	CONSTANT	0.530	-999.	0.000E+00	100.
Bulk density of soil for layer	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Biological decay coefficient	1/yr	CONSTANT	0.100E-04	-999.	0.000E+00	-999.

CHEMICAL SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Solid phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Dissolved phase decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Overall chemical decay coefficient	1/yr	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Acid catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Neutral hydrolysis rate constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Base catalyzed hydrolysis rate	l/M-yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Reference temperature	C	CONSTANT	25.0	-999.	0.000E+00	100.
Normalized distribution coefficient	ml/g	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Distribution coefficient	--	DERIVED	-999.	-999.	0.000E+00	0.100E+11
Biodegradation coefficient (sat. zone)	1/yr	CONSTANT	0.100E-03	-999.	0.000E+00	-999.
Air diffusion coefficient	cm2/s	CONSTANT	0.000E+00	-999.	0.000E+00	10.0
Reference temperature for air diffusion	C	CONSTANT	25.0	-999.	0.000E+00	100.
Molecular weight	g/M	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Mole fraction of solute	--	CONSTANT	0.000E+00	-999.	0.100E-08	1.00
Vapor pressure of solute	mm Hg	CONSTANT	0.000E+00	-999.	0.000E+00	100.
Henry's law constant	atm-m^3/M	CONSTANT	0.000E+00	-999.	0.100E-09	1.00
Overall 1st order decay sat. zone	1/yr	DERIVED	0.000E+00	0.000E+00	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00
Not currently used		CONSTANT	-999.	-999.	0.000E+00	1.00

SOURCE SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Infiltration rate	m/yr	CONSTANT	0.100E-03	-999.	0.100E-09	0.100E+11
Area of waste disposal unit	m^2	CONSTANT	0.388E+05	-999.	0.100E-01	-999.
Duration of pulse	yr	CONSTANT	-999.	-999.	0.100E-08	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	0.100E-08	0.100E+11
Recharge rate	m/yr	CONSTANT	0.100E-03	-999.	0.000E+00	0.100E+11
Source decay constant	1/yr	CONSTANT	0.000E+00	-999.	0.000E+00	-999.
Initial concentration at landfill	mg/l	CONSTANT	0.660	-999.	0.000E+00	-999.
Length scale of facility	m	DERIVED	210.	-999.	0.100E-08	0.100E+11
Width scale of facility	m	DERIVED	185.	-999.	0.100E-08	0.100E+11
Near field dilution		DERIVED	1.00	0.000E+00	0.000E+00	1.00

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS MEAN	PARAMETERS STD DEV	LIMITS MIN	LIMITS MAX
Particle diameter	cm	CONSTANT	0.100E-01	-999.	0.100E-08	100.
Aquifer porosity	--	CONSTANT	0.260	-999.	0.100E-08	0.990
Bulk density	g/cc	CONSTANT	1.76	-999.	0.100E-01	5.00
Aquifer thickness	m	CONSTANT	100.	-999.	0.100E-08	0.100E+06
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	0.100E-08	0.100E+06
Conductivity (hydraulic)	m/yr	CONSTANT	0.540E-01	-999.	0.100E-06	0.100E+09
Gradient (hydraulic)		CONSTANT	0.500E-01	-999.	0.100E-07	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	0.100E-09	0.100E+09
Retardation coefficient	--	CONSTANT	10.0	-999.	1.00	0.100E+09
Longitudinal dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Vertical dispersivity	m	FUNCTION of X	-999.	-999.	-999.	-999.
Temperature of aquifer	C	CONSTANT	13.0	-999.	0.000E+00	100.
pH	--	CONSTANT	7.50	-999.	0.300	14.0
Organic carbon content (fraction)		CONSTANT	0.310E-02	-999.	0.100E-05	1.00
Well distance from site	m	CONSTANT	30.5	-999.	1.00	-999.
Angle off center	degree	CONSTANT	5.00	-999.	0.000E+00	360.
Well vertical distance	m	CONSTANT	0.100E-01	-999.	0.000E+00	1.00

CONCENTRATION AFTER SATURATED ZONE MODEL 0.3120E-01 mg/l.

(TCLP ANALYSES OF COAL COMBUSTION ASH)

RESEARCH & ANALYTICAL LABORATORIES, INC.
Analytical/Process Consultations

R.J. Reynolds Tobacco Company
P.O. Box 2959, P/LS-F1.4A
Winston-Salem, NC 27102
Attn: Bill Howard

Date Sample Collected : 06/01/93
Date Sample Received : 06/03/93
Date Sample Analyzed : 06/04/93
Date of Report : 07/06/93
Analyses Performed by : SK -TB -DW

Job Number : 00419 K

Lab Sample Number
169452

Parameter	Storet #	Results
Arsenic, TCLP		<0.050 MG/L
Barium, TCLP		0.25 MG/L
Cadmium,TCLP		<0.010 MG/L
Chromium, TCLP		0.13 MG/L
Lead, TCLP		<0.10 MG/L
Mercury, TCLP		<0.002 MG/L
Selenium, TCLP		0.57 MG/L
Silver, TCLP		<0.010 MG/L
Arsenic,Tot	(01002)	46 MG/KG
Barium,Tot	(01007)	210 MG/KG
Cadmium,Tot	(01027)	0.79 MG/KG
Chromium,Tot	(01034)	37.3 MG/KG
Lead,Tot	(01051)	90 MG/KG
Mercury,Tot	(71900)	0.75 MG/KG
Selenium,Tot	(01147)	99.2 MG/KG
Silver,Tot	(01077)	<0.66 MG/KG
BTU		3169/LB

Clients Sample Source/Number : 602 UP FLY ASH
Time Collected (Hrs) :

RESEARCH & ANALYTICAL LABORATORIES, INC.
Analytical/Process Consultations

R.J. Reynolds Tobacco Company
P.O. Box 2959, P/LS-F1.4A
Winston-Salem, NC 27102
Attn: Bill Howard

Date Sample Collected : 06/01/93
Date Sample Received : 06/03/93
Date Sample Analyzed : 06/04/93
Date of Report : 07/06/93
Analyses Performed by : SK -TB -GL

Job Number : 00419 K

Lab Sample Number
169451

Parameter	Storet #	Results
Arsenic, TCLP		<0.050 MG/L
Barium, TCLP		0.66 MG/L
Cadmium,TCLP		<0.010 MG/L
Chromium, TCLP		<0.020 MG/L
Lead, TCLP		<0.10 MG/L
Mercury, TCLP		<0.002 MG/L
Selenium, TCLP		<0.10 MG/L
Silver, TCLP		<0.010 MG/L
Arsenic,Tot	(01002)	<0.62 MG/KG
Barium,Tot	(01007)	10.8 MG/KG
Cadmium,Tot	(01027)	<0.625 MG/KG
Chromium,Tot	(01034)	17.4 MG/KG
Lead,Tot	(01051)	<6.25 MG/KG
Mercury,Tot	(71900)	<0.12 MG/KG
Selenium,Tot	(01147)	<0.31 MG/KG
Silver,Tot	(01077)	<0.63 MG/KG
BTU		699/LB

Clients Sample Source/Number : 602 UP
Time Collected (Hrs) :

RESEARCH & ANALYTICAL LABORATORIES, INC.

Analytical/Process Consultations

R.J. Reynolds Tobacco Company
P.O. Box 2959, P/LS-Fl.4A
Winston-Salem, NC 27102
Attn: Bill Howard

Date Sample Collected : 06/01/93
Date Sample Received : 06/03/93
Date Sample Analyzed : 06/04/93
Date of Report : 07/06/93
Analyses Performed by : SK -TB -GL

Job Number : 00419 K

Lab Sample Number
169453

Parameter	Storet #	Results
Arsenic, TCLP		<0.050 MG/L
Barium, TCLP		0.47 MG/L
Cadmium,TCLP		<0.010 MG/L
Chromium, TCLP		0.084 MG/L
Lead, TCLP		<0.10 MG/L
Mercury, TCLP		<0.002 MG/L
Selenium, TCLP		<0.10 MG/L
Silver, TCLP		<0.010 MG/L
Arsenic,Tot	(01002)	14 MG/KG
Barium,Tot	(01007)	536 MG/KG
Cadmium,Tot	(01027)	<0.57 MG/KG
Chromium,Tot	(01034)	10.9 MG/KG
Lead,Tot	(01051)	14.4 MG/KG
Mercury,Tot	(71900)	0.52 MG/KG
Selenium,Tot	(01147)	21.5 MG/KG
Silver,Tot	(01077)	<0.57 MG/KG
BTU		1850/LB

Clients Sample Source/Number : TOBACCOVILLE UP
Time Collected (Hrs) :

RESEARCH & ANALYTICAL LABORATORIES, INC.

Analytical/Process Consultations

R.J. Reynolds Tobacco Company
P.O. Box 2959, P/LS-F1.4A
Winston-Salem, NC 27102
Attn: Bill Howard

Date Sample Collected : 06/01/93
Date Sample Received : 06/03/93
Date Sample Analyzed : 06/04/93
Date of Report : 07/06/93
Analyses Performed by : SK -TB -DW

Job Number : 00419 K

Lab Sample Number
169454

Parameter	Storet #	Results
Arsenic, TCLP		<0.050 MG/L
Barium, TCLP		0.44 MG/L
Cadmium,TCLP		0.015 MG/L
Chromium, TCLP		0.082 MG/L
Lead, TCLP		<0.10 MG/L
Mercury, TCLP		<0.002 MG/L
Selenium, TCLP		<0.10 MG/L
Silver, TCLP		0.012 MG/L
Arsenic,Tot	(01002)	15 MG/KG
Barium,Tot	(01007)	137 MG/KG
Cadmium,Tot	(01027)	<0.60 MG/KG
Chromium,Tot	(01034)	24.1 MG/KG
Lead,Tot	(01051)	22.2 MG/KG
Mercury,Tot	(71900)	<0.12 MG/KG
Selenium,Tot	(01147)	<6.02 MG/KG
Silver,Tot	(01077)	<0.60 MG/KG
BTU		2249/LB

Clients Sample Source/Number : BAILEY UP
Time Collected (Hrs) :

(STREAM SAMPLING DATA)

SS-001

Parameter	Units	4/29/88			9/6/90	9/21/90	10/23/91	3/25/92	9/29/92				
Aluminum,total	mg/l	<0.152				0.14	0.109	4.15	<0.10				
Arsenic, total	mg/l	<0.011			<0.010	<0.010	<0.010	<0.010	<0.010				
Barium, total	mg/l	0.118			0.064	<0.080	<0.080	<0.080	<0.100				
Cadmium, total	mg/l	0.008			<0.0010	0.0048	<0.002	0.0034	<0.002				
Copper, total	mg/l	<0.019				<0.020	<0.020	<0.020	<0.020				
Chromium, total	mg/l	<0.016				<0.040	<0.040	<0.020	<0.040				
Iron, total	mg/l	0.086				0.20	<0.10	5.0	0.160				
Lead, total	mg/l	<0.024			<0.0025	<0.005	<0.005	0.0158	<0.005				
Manganese,total	mg/l	<0.014				<0.020	<0.020	0.064	0.085				
Mercury, total	mg/l	<0.0002			<0.0002	<0.0002	<0.0002	<0.0002	<0.0002				
NO-3-N	mg/l	0.22				0.52	0.15	0.25	0.190				
Selenium, total	mg/l	<0.005			<0.005	<0.005	<0.005	<0.005	<0.005				
Silver, total	mg/l	<0.014			<0.0050	<0.010	<0.010	<0.010	<0.010				
Sulfate	mg/l	64				40.0	108	9.4	84.0				
Zinc, total	mg/l	0.015				<0.020	<0.020	<0.020	<0.020				
pH	STD	6.8			7.9	7.18	7.9	5.80	5.73				
TDS	mg/l	220				352	248	185	241				
Temp	°C					11.6	17.2	11.3	13.8				
TOC	mg/l	2.81				12.0	12.0	14	2				
Conductivity						490	381	126	356				

SS-002

Parameter	Units				9/6/90	9/21/90	10/23/91	3/25/92	9/29/92				
Aluminum,total	mg/l					0.13	<0.10	7.65	0.330				
Arsenic, total	mg/l				<0.010	<0.010	<0.010	<0.010	<0.010				
Barium, total	mg/l				0.070	0.094	0.170	<0.080	<0.100				
Cadmium, total	mg/l				0.0010	0.0046	<0.002	0.0021	<0.002				
Copper, total	mg/l					<0.020	<0.020	<0.020	<0.020				
Chromium, total	mg/l				0.021	<0.040	<0.040	<0.020	<0.040				
Iron, total	mg/l					0.10	0.82	8.07	<0.100				
Lead, total	mg/l				<0.0050	<0.005	<0.005	0.0129	<0.005				
Manganese,total	mg/l					<0.020	0.711	0.130	<0.015				
Mercury, total	mg/l				<0.0002	<0.0002	<0.0002	<0.0002	<0.0002				
NO-3-N	mg/l					1.14	1.02	0.25	0.550				
Selenium, total	mg/l				<0.005	<0.005	<0.005	<0.005	0.0073				
Silver, total	mg/l				<0.005	<0.010	<0.010	<0.010	<0.010				
Sulfate	mg/l					47	490	13.1	183				
Zinc, total	mg/l					<0.020	0.08	<0.020	<0.020				
pH	STD				7.8	7.52	7.82	6.04	6.07				
TDS	mg/l					141	806	149	474				
Temp	°C					14.6	18.0	11.5	15.1				
TOC	mg/l					15.0	10.0	12	3				
Conductivity						607	1,280	111	778				

(HELP MODEL COMPUTER ANALYSIS)

****
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RJRRUN1
RJ REYNOLDS PHASE III - SUBAREA B, SECTION 1 - RECHARGE
AUGUST 1993

****
****

FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS = 24.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1800 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = 0.000001000000 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS = 600.00 INCHES
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL

WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = 0.000010000000 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER
THICKNESS = 120.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2500 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = 0.000001000000 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER = 0.00
TOTAL AREA OF COVER = 248292. SQ FT
EVAPORATIVE ZONE DEPTH = 21.00 INCHES
UPPER LIMIT VEG. STORAGE = 9.0300 INCHES
INITIAL VEG. STORAGE = 4.0639 INCHES
INITIAL SNOW WATER CONTENT = 0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN
SOIL AND WASTE LAYERS = 214.3200 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR GREENSBORO NORTH CAROLINA

MAXIMUM LEAF AREA INDEX = 2.00

START OF GROWING SEASON (JULIAN DATE) = 100
END OF GROWING SEASON (JULIAN DATE) = 302

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
37.50	39.90	48.00	58.30	66.50	73.50
77.20	76.30	69.90	58.40	48.50	40.20

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	4.43	1.99	4.38	2.21	4.14	2.73
	5.32	4.79	5.44	3.60	2.36	3.98
STD. DEVIATIONS	2.28	1.14	2.58	1.21	2.31	1.09
	5.09	3.03	2.32	3.18	0.62	0.26
RUNOFF						
TOTALS	3.321	1.089	2.738	1.315	2.576	1.537
	3.978	3.414	4.337	2.792	1.535	2.906
STD. DEVIATIONS	2.004	0.776	2.255	1.069	1.561	0.786
	4.180	2.606	1.978	2.705	0.348	0.336
EVAPOTRANSPIRATION						
TOTALS	1.209	0.924	1.581	0.934	1.554	1.270
	1.320	1.354	1.109	0.815	0.708	1.078
STD. DEVIATIONS	0.272	0.412	0.401	0.267	0.881	0.395
	0.966	0.403	0.571	0.538	0.182	0.192

PERCOLATION FROM LAYER 3

TOTALS	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003
STD. DEVIATIONS	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	45.37	(10.898)	938751.	100.00
RUNOFF	31.538	(9.235)	652552.	69.51
EVAPOTRANSPIRATION	13.855	(2.297)	286674.	30.54
PERCOLATION FROM LAYER 3	0.0023	(0.0023)	48.	0.01
CHANGE IN WATER STORAGE	-0.025	(0.179)	-524.	-0.06

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	4.73	97868.4
RUNOFF	4.595	95066.6
PERCOLATION FROM LAYER 3	0.0000	0.5
SNOW WATER	0.92	19035.7

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2111

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1800

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.49	0.1869
2	172.88	0.2881
3	37.11	0.3092

SNOW WATER 0.00

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RJRRUN1
RJ REYNOLDS PHASE III - SUBAREA B, SECTION 1
AUGUST 1993

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

```
THICKNESS                          =    24.00 INCHES
POROSITY                           =    0.4300 VOL/VOL
FIELD CAPACITY                     =    0.3210 VOL/VOL
WILTING POINT                      =    0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT         =    0.1800 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY   =    0.000001000000 CM/SEC
```

LAYER 2

VERTICAL PERCOLATION LAYER

```
THICKNESS                          =   600.00 INCHES
POROSITY                           =    0.4530 VOL/VOL
FIELD CAPACITY                     =    0.1900 VOL/VOL
```

WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = 0.000010000000 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER
THICKNESS = 120.00 INCHES
POROSITY = 0.4300 VOL/VOL
FIELD CAPACITY = 0.3210 VOL/VOL
WILTING POINT = 0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2500 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY = 0.000001000000 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER = 0.00
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EVAPORATIVE ZONE DEPTH = 21.00 INCHES
UPPER LIMIT VEG. STORAGE = 9.0300 INCHES
INITIAL VEG. STORAGE = 4.0639 INCHES
INITIAL SNOW WATER CONTENT = 0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN
SOIL AND WASTE LAYERS = 214.3200 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR GREENSBORO NORTH CAROLINA

MAXIMUM LEAF AREA INDEX = 2.00

START OF GROWING SEASON (JULIAN DATE) = 100
END OF GROWING SEASON (JULIAN DATE) = 302

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

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37.50	39.90	48.00	58.30	66.50	73.50
77.20	76.30	69.90	58.40	48.50	40.20

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

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PRECIPITATION						
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STD. DEVIATIONS	2.28	1.14	2.58	1.21	2.31	1.09
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RUNOFF						
TOTALS	3.321	1.089	2.738	1.315	2.576	1.537
	3.978	3.414	4.337	2.792	1.535	2.906
STD. DEVIATIONS	2.004	0.776	2.255	1.069	1.561	0.786
	4.180	2.606	1.978	2.705	0.348	0.336
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TOTALS	1.209	0.924	1.581	0.934	1.554	1.270
	1.320	1.354	1.109	0.815	0.708	1.078
STD. DEVIATIONS	0.272	0.412	0.401	0.267	0.881	0.395
	0.966	0.403	0.571	0.538	0.182	0.192

PERCOLATION FROM LAYER 3

TOTALS	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003
STD. DEVIATIONS	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0003

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	45.37	(10.898)	1580388.	100.00
RUNOFF	31.538	(9.235)	1098573.	69.51
EVAPOTRANSPIRATION	13.855	(2.297)	482617.	30.54
PERCOLATION FROM LAYER 3	0.0023	(0.0023)	80.	0.01
CHANGE IN WATER STORAGE	-0.025	(0.179)	-881.	-0.06

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	4.73	164761.7
RUNOFF	4.595	160044.7
PERCOLATION FROM LAYER 3	0.0000	0.8
SNOW WATER	0.92	32046.7

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2111

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1800

****

****

FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.49	0.1869
2	172.88	0.2881
3	37.11	0.3092

SNOW WATER 0.00

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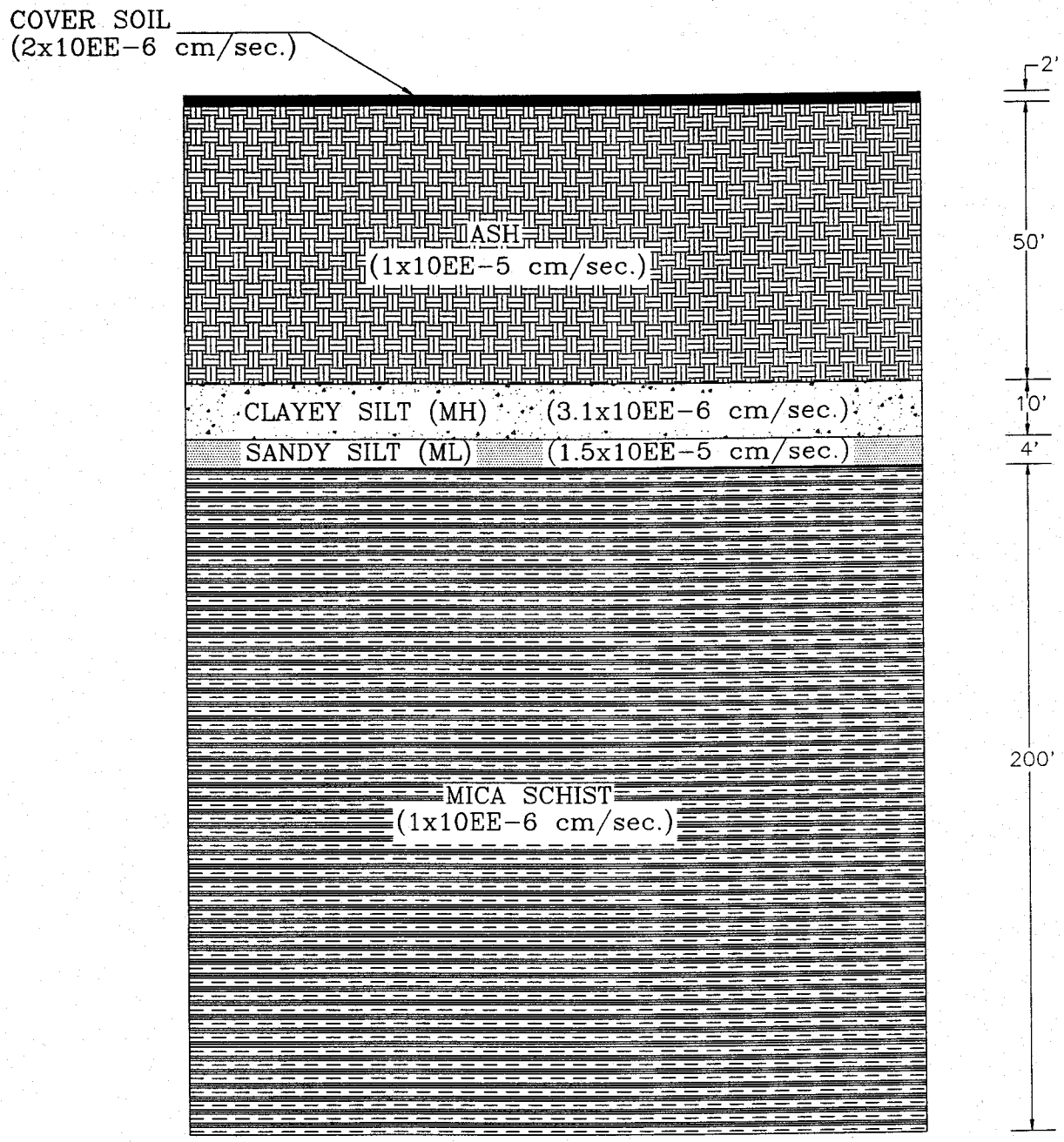

GCI

R.J. REYNOLDS TOBACCO CO.
ASH MANAGEMENT AREA
FORSYTH COUNTY, N.C.

TYPICAL LANDFILL SECTION

PROJECT #: 93011	DATE: 10-14-93	PROJECT MGR: C.D.H.
		DESIGN BY: N.A.
		DRAWN BY: C.N.I.
		SCALE: N.T.S.

GEO-ENVIRONMENTAL CONSULTANTS, INC.
GEOTECHNICAL/ENVIRONMENTAL ENGINEERS & SCIENTISTS
1016 McCLELLAND COURT, CHARLOTTE, NC 28206
PHONE (704)332-2060 FAX (704)334-0405

FIGURE

KBK

REPORT

KBK Enterprises, Inc.

PRELIMINARY EVALUATION OF TH
COAL ASH PRODUCED AT THE
BAILEY, TOBACCOVILLE, AND
WHITAKER PARK PLANTS

PRELIMINARY EVALUATION OF THE COAL ASH PRODUCED AT THE BAILEY, TOBACCOVILLE, AND WHITAKER PARK PLANTS

Prepared for:

R.J. Reynolds Tobacco Company

Prepared By:

KBK Enterprises, Inc.
777 Franklin Road
Marietta, Georgia 30067
(404) 426-5944

June 1989

DISCLAIMER

All data, information, and statements provided in this report are supplied to furnish F. J. Reynolds a preliminary determination of the suitability of the RJR ash for any application, KBK recommends that further testing and evaluation of the ash be performed. Therefore, KBK does not warrant this data nor the RJR ash for any application and suggests the material user perform an independent technical review of the RJR ash prior to utilization.

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SECTION 1.0

INTRODUCTION

In November, 1988, R.J. Reynolds Company (RJR) of Winston Salem, North Carolina contracted with KBK Enterprises Inc. (KBK) of Marietta, Georgia to provide preliminary testing and review of the fly ash generated at three (3) plants relative to structural fill applications such as real estate development. The three (3) plants to be sampled were:

1. Bailey Plant
2. Tobaccoville Plant
3. Whitaker Park Plant

To initiate the study, ash samples were collected by KBK in December, 1988. The following physical characterization tests were performed to allow preliminary review of the material quality:

1. Moisture Density Test (Standard Proctor)
2. Gradation Test (Sieve Analysis)
3. Consolidation Test
4. Loss on Ignition Test

In addition to the tests listed above, RJR supplied KBK with E.P. Toxicity test data on the fly ash from each plant. KBK reviewed the limited environmental data relative to permitting of structural fills.

End of Section

SECTION 2.0

BACKGROUND INFORMATION ON TESTS

2.1 Moisture/Density (Standard Proctor)

In designing and constructing a structural fill or embankment, the degree of compaction is one of the primary concerns in providing a final product that performs within the properties it has been designed to achieve. While the obvious effect of compaction is the densification of the soil or ash particles and the expulsion of air, the main purpose is to produce a soil mass with controlled engineered properties. A properly compacted soil or ash fill will perform to its designed strength with limited and predictable settlement, and with limited and predictable permeability.

For a given soil (or ash) there is a moisture content and compactive effort which achieves the highest degree of compaction or densification. The Standard Proctor Test (ASTM D698) is a widely used test for determining the moisture content of the soil which gives the highest dry unit weight or density of the soil. In this test, the soil sample's moisture content is plotted against the dry density unit weight and a parabola figure typically results (See test data, Appendix 1). The peak of the curve indicates the maximum dry density for the sample and the moisture content at which it occurs.

The maximum dry density of a sample is theoretically the highest degree of densification for the sample. Field compaction for a soil is usually referred to as a percentage of the maximum dry density. Generally when designing a structural fill, an engineer will use the properties of the soil mass determined if it is compacted to a percentage of maximum dry density; typically 90% for non-load bearing areas, 95% for pavement areas, and 98% to 100% for foundations of structures. The moisture/density curve can be used to determine the tolerances for moisture and compaction energy levels to obtain the required densities.

The moisture/density curve can also aid in determining the stability of a sample if it is too wet or too dry. A moisture/density curve which is very steep to the peak, indicates a material in which the moisture content greatly effects the densification. Therefore, to use this material, the moisture content would need to be tightly controlled, which in practice is very difficult to achieve.

2.2 Gradation Test

The Gradation Test is used to classify a soil sample by the soil particle sizes and the percentage of each size

within the whole sample. The percentage of coarse grained particles are found by using a mechanical sieve test (ASTM D422) while fine grain soils (smaller than No. 200) are found by using a dispersion test, or Hydrometer (ASTM D422). The results of the particle size test are graphed as a particle size distribution curve.

The soil can be classified by using the USDA Triangle Chart (figure 1) which is used for sands, silts, and clays. In using this chart particle sizes are defined as follows:

Sand - 0.05 - 2.0 mm
Silt - 0.002 - 0.05 mm
Clay - <0.002 mm

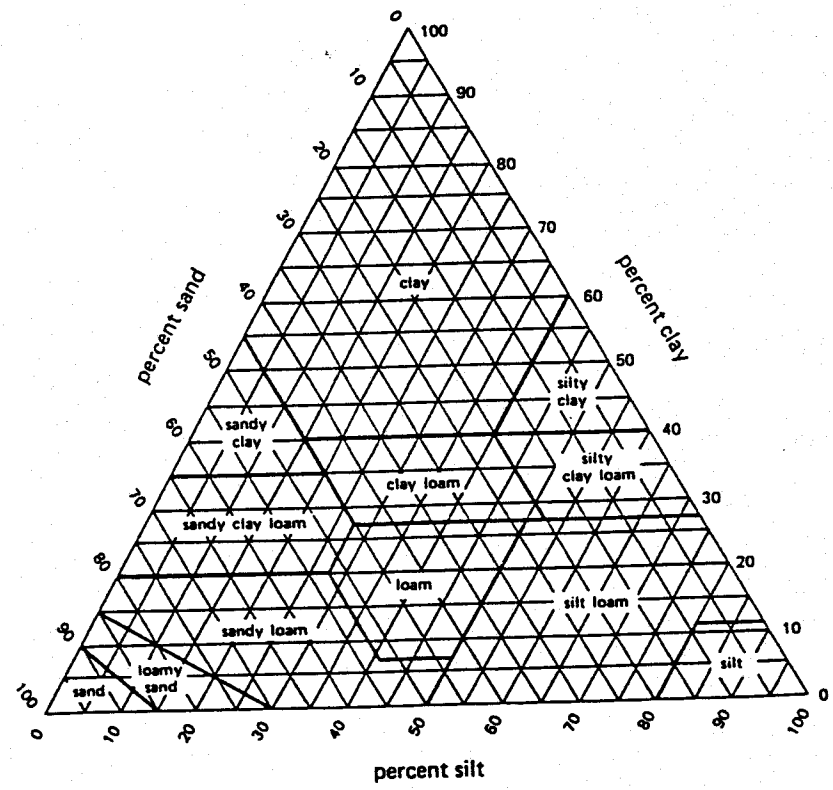


FIGURE 1.

The soil classification can be used to compare the soil sample to a familiar soil with a similar classification. This enables an evaluation to predict the field characteristics of a soil sample by the known characteristics of similar soil.

The Gradation Test can be used to approximately predict the soil's susceptibility to frost action capillary rise, and the soil's permeability. Typically, soils subject to frost action are well graded soils containing more than 3 percent of particles smaller than 0.02 mm.

Capillary rise of water through a soil can be determined using the effective particle size and the surface tension for the soil. Using a nominal surface tension of 0.075 g/cm, the capillary rise for each of the fly ash samples has been estimated to be between 6.5 and 12 feet (depending upon permeability), which is considered to be critical. A more accurate determination of capillary rise in a soil sample can be determined by performing ASTM D3152.

Permeability of a soil sample can be estimated by determining the soil classification. Typical permeability ranges for soils classified as Silt are between $1X10^{-5}$ and $1X10^{-7}$. Permeability can be greatly effected by the compacted dry density of the soil. A more accurate determination of the permeability of a soil sample can be determined by performing ASTM D2434.

2.3 Consolidation Test

If soils subjected to an increase in effective stress, the soils will decrease in volume or consolidate. The stress increase may be caused by structure foundations, embankments, or even lowering of the groundwater table. If the soil supports a structure and the settlement due to consolidation is excessive, damage may result. These settlements may be estimated if the soil's compressibility and stress loads are known.

The Consolidation Test (ASTM D2435) is used to determine the amount of consolidation which occurs to a soil sample when subjected to increasing increments of one dimensional loading for an extended period of time. The amount of consolidation for each load increment is expressed as a percentage of the constant stress and is plotted against the load pressure (See test data, Appendix 1). The slope of the line given by the graph of stress vs. load is the Compression Index (C_c). Using a variant of Boussineq's equation, C_c can be used to estimate the amount of settlement which would occur due to the loads for a building footing:

$$H = \frac{h_1 C_c}{I + e_1} \log_{10} \frac{P'_2}{P'_1}$$

While the Consolidation test gives a good overall estimate of settlement and bearing strengths additional testing can provide more precise data for non-cohesive materials such as fly ash. These tests include Standard Penetration Tests ASTM D3441 and ASTM D2850, and others. The more extensive testing would be of value where structural foundations are being designed for specific end uses.

2.4 Loss on Ignition

Bituminous coal fly ash is typically composed of Silica Oxide (SiO_2), Alumina Oxide (AlO_3), Ferric Oxide (Fe_2O_3), and various other oxides and alkalies. Volatiles such as carbon may also be present, and the content is dependent upon the efficiency of the combustion process and the fineness of the coal upon combustion. The carbon content of the fly ash is important in determining the characteristics of the ash when used as structural fill due to the carbon's potential to effect compaction and strength characteristics. Depending upon the structure of the carbon, it could have the potential to deteriorate over time and cause settlement.

The Loss on Ignition (LOI) Test is a procedure from ASTM C311 and is used to measure the amount of material which is ignited and consumed at a temperature of 750°C. The amount of material consumed is expressed as a percentage of the initial sample weight.

In addition to being a critical characteristic, related ash utilization potential L.O.I. test data can be helpful as an indicator of operational efficiency of a boiler. A consistently high L.O.I. can indicate loss of heat value of the fuel source.

Ash Source	% L.O.I
Bailey Plant	8.7%
Tobaccoville	25.41%
Whitaker Park	17.73%

End of Section

SECTION 3

BAILEY PLANT TEST DATA

3.1 Moisture Density

The fly ash from the Bailey Plant was found to have a maximum dry density of 65.5 (pcf) at a moisture content of 46.0%, also called the optimum moisture content (see Appendix 1). The moisture/density curve is considered to be moderate on the dry side of optimum and tapers off after 5% less than optimum. On the wet side of optimum moisture, the curve is moderate to steep. This would indicate that the density of the ash will not be significantly effected by less than optimum moisture, but could potentially become unstable if more moisture than optimum exists.

3.2 Gradation

The fly ash from the Bailey Plant was found to have approximately 12% of the particles classified as sand and the remaining 88% classified as silt (see Appendix 1). Using the USDA triangle chart, the ash sample is classified as Silt. Using the gradation curve, the sharply sloping curve further classifies the soil sample into a subcategory of poorly graded.

Bailey ash
- Silt, poorly graded
- Frost Action: susceptible
- Capillary Rise: critical
- Permeability: 10^{-5} to 10^{-7}, low

3.3 Consolidation

The fly ash from the Bailey Plant was tested for Consolidation using a sample compacted to a dry density of 62.7 pcf or 95.7% of Standard Proctor (see Appendix 1). The sample achieved a Compression Index of 0.07 at a saturation of 76.1% (yields a void ratio (e) = 1.387). Using the Boussineq's equation and practical assumptions, it is estimated that a 60 inch height fill of the fly ash material compacted to 95.7% would consolidate 1.80 inches when subjected to a load of 1500 psf. This amount of consolidation indicates that the fly ash would be acceptable (without detrimental settlement) as structural fill for pavement areas, and could possibly support designed footing loads if compacted to 100% of dry density. For footing design applications the test data should be expanded and duplicated.

3.4 Loss on Ignition

Sample analysis of the Bailey Plant fly ash indicates a Loss on Ignition of 8.7 percent. An L.O.I. greater than 4 percent greatly restricts most applications of fly ash as a concrete additive.

End of Section

SECTION 4

TOBACCOVILLE PLANT TEST DATA

4.1 Moisture Density

The fly ash from the Tobaccoville Plant was found to have a maximum dry density of 48.6 pcf and an optimum moisture content of 69.8% (see Appendix 1). The moisture/density curve is considered to be moderate on the dry side of optimum and tapers off after 5% less than optimum. On the wet side of the optimum, the curve is moderate to steep. This would indicate that the density of the soil will not be significantly effected by less than optimum moisture, but could potentially become unstable if more moisture than optimum exists.

4.2 Gradation

The fly ash from the Tobaccoville Plant was found to have approximately 17% of the particles classified as sand and the remaining 83% classified as silt (See Appendix 1). Using the USDA Triangle Chart, the ash sample is classified as Silt. Using the gradation curve, the sharply sloping curve further classifies the ash sample into a subcategory of poorly graded.

Tobaccoville ash - Silt, poorly graded
- Frost Action: susceptible
- Capillary Rise: critical
- Permeability: 10^{-5} to 10^{-7}, low

4.3 Consolidation

The fly ash from the Tobaccoville Plant was tested for Consolidation using a sample compacted to a dry density of 45.8 pcf or 94.2% of Standard Proctor (see Appendix 1). The sample achieved a Compression Index of 0.41 at a saturation of 73.8% (yields a void ratio (e) = 1.960). Using the Boussineq's equation and practical assumptions, it is estimated that a 60 inch height fill of fly ash compacted to 94.8% would consolidate 9.55 inches when subjected to a load of 1500 pcf. This amount of consolidation indicates that the fly ash would not be acceptable as structural fill but could possibly be used for non-load, non-traffic bearing fill such as landscaped berms.

4.4 Loss on Ignition

Sample analysis of the Tobaccoville Plant fly ash indicates a Loss on Ignition of 25.41 percent.

End of Section

SECTION 5

WHITAKER PARK TEST DATA

5.1 Moisture Density

The fly ash from the Whitaker Park Plant was found to have a maximum dry density of 63.0 pcf and an optimum moisture content of 43.0% (see Appendix 1). The moisture/density curve is considered to be moderate to steep on the dry side of optimum and continues to lose density as moisture is reduced. On the wet side of optimum the curve is moderate to steep. This would indicate that the ash could potentially become unstable if compaction is attempted with the moisture above or below optimum. In field applications, controlling the moisture content this closely is very difficult. This in turn will make it difficult to achieve the desired density unless the compaction energy level can be increased without overstressing the ash.

5.2 Gradation

The fly ash from the Whitaker Park Plant was found to have approximately 15% of the particles classified as sand and the remaining 85% classified as silt (see Appendix 1). Using the USDA Triangle Chart, the ash sample is classified as Silt. Using the gradation curve, the sharply sloping curve further classifies the ash sample into a subcategory of poorly graded.

Whitaker Park ash
- Silt, poorly graded
- Frost Action: susceptible
- Capillary Rise: critical
- Permeability: 10^{-5} to 10^{-7}, low

5.3 Consolidation

The fly ash from the Whitaker Park Plant was tested for Consolidation using a sample compacted to a dry density of 62.3 pcf or 98.9% of Standard Proctor (see Appendix 1). The sample achieved a Compression Index of 0.25 at a saturation of 62.3% (yields a void ratio (e) = 1.59). Using the consolidation equation and assumptions, it is estimated that a 60 inch height fill of the fly ash material compacted to 98.9% would consolidate 6.31 inches when subjected to a load of 1500 psf. This amount of consolidation indicates that fly ash would be acceptable as structural fill for non-load bearing, low-traffic applications such as recreational fields, but would not be acceptable for pavement areas or building areas. Also, the fly ash should be compacted to a dry density at or near 100% of Standard Proctor for better control of the engineered properties of the fill.

5.4 Loss on Ignition

Sample analysis of the Whitaker Plant fly ash indicates a Loss on Ignition of 17.73 percent.

End of Section

SECTION 6.0

ENVIRONMENTAL REVIEW

6.01 General

Under the Resource Conservation and Recovery Act of 1976 (RCRA), Congress established the legal authority for the U.S. Environmental Protection Agency (EPA) to promulgate regulations to govern the management of solid and hazardous wastes. The regulations provide that coal combustion by-products are "conditionally exempt" from regulation as a hazardous waste. Congress directed EPA to study the scope of coal ash management practices and report on the existing practices and environmental impacts.

In EPA's draft Report to Congress the agency noted that few coal combustion ashes exhibit hazardous characteristics and that utilization of coal ash should be promoted where environmentally safe. Neither Congress nor EPA have altered the conditional exemption from RCRA regulation which coal ash enjoys partly due to the factual recognition that very few coal ashes present environmental hazards as a hazardous waste. Most coal ashes contain only trace concentrations of heavy metals and very rarely exhibit hazardous characteristics.

Without regulation as a hazardous waste under Subtitle C of RCRA, coal ash is regulated as a Subtitle D solid waste and is usually governed by a State environmental statute and a related regulatory program.

6.2 State Regulations

The North Carolina the regulation of solid waste falls under the authority of the North Carolina Department of Natural Resources and Community Development (DNR). Permits to dispose of solid wastes such as fly ash and bottom ash are issued by DNR. Conditional permits are issued for the utilization of coal ash in markets such as structural fill, flowable fill, certain backfills, ice control, pipe bedding and certain other limited uses.

In the North Carolina Department of Human Resources is responsible for the administration of National Pollutant Discharge System (NPDES) in North Carolina and the issuance and enforcement of permits for any activity which in the WCB's opinion could potentially effect surface and ground water sources. DHR maintains the EPA units for hazardous waste and drinking water standards, and has policies prohibiting degradation of groundwater supplies. Therefore the fly ash must be controlled as a solid waste under permits issued by the DHR. Recently, the DHR has taken favorable positions on the reuse of the fly ash as fill

material. The permits are issued with specified conditions and limitations designed to protect the environment and groundwater from degradation due to leachate from the fly ash. In most cases, the conditions of the permit are easily met with the proper design and construction of the fly ash fill.

6.3 E. P. Toxicity Test

Coal Ash typically contains traces, or concentrations of heavy metal substances which are regulated as Hazardous Waste by the EPA and state environmental regulatory agencies. Though almost all coal ashes do not contain large enough concentrations of heavy metals to be classified as Hazardous Waste, the concerns of leachate from coal ash fills possibly contaminating or degradating ground water supplies are of concern when analyzing and designing a coal ash fill. For this reason, the fly ash must be tested using the E.P. Toxicity Test to determine the concentrations of heavy metals leachate, and the fly ash fill project must be designed and constructed to minimize the potential for leachate to reach the ground water supply.

The E.P. Toxicity test involves subjecting a waste sample to an acid extraction which approximates a "worst case" leaching scenario for a land filled waste material. The chemical analysis for heavy metal concentrations then gives a measure of the potential environmental impact from the migration of metals present in the waste stream. Many other physical and chemical factors play an important role in determining the propensity for heavy metal migration in the open environment; however, the E.P. Toxicity test provides a good commonly used "yardstick".

6.2 RJR Data

For the proposes of this report, RJR supplied E.P. Toxicity test data for each of the three (3) plants. Table 6.1 lists the results of the data compared to the hazardous waste standards. Based on the analysis provided by RJR, the heavy metal concentrations are well below the standards for a hazardous waste and most parameters are below the drinking water standard which is one hundred times less than the hazardous waste limit.

It should be noted that with the exception of the Tobaccoville data, the analysis data provided is dated back to 1979 and appears to be incomplete for certain parameters.

Table 6.1

	Tobaccoville Ash	EPA Hazardous Waste Limits	Drinking Water Limits
Arsenic	<0.010	5.0	0.05
Barium	0.015	100.0	1.00
Cadmium	<0.010	1.0	0.01
Chromium	0.029	5.0	0.05
Lead	<0.010	5.0	0.05
Selenium	0.051	1.0	0.01
Silver	<0.016	5.0	0.05
Mercury	0.0003	0.2	0.002

	Bailey	EPA Hazardous Waste Limits	Drinking Water Limits
Arsenic	0	5.0	0.05
Barium	0.20	100.0	1.00
Cadmium	0	1.0	0.01
Chromium	0.02	5.0	0.05
Lead	0	5.0	0.05
Selenium	0.018	1.0	0.01
Silver	0.0	5.0	0.05
Mercury	0	0.2	0.002

	Whitaker Park	EPA Hazardous Waste Limits	Drinking Water Limits
Arsenic	0.10	5.0	0.05
Barium	0.02	100.0	1.00
Cadmium	0.15	1.0	0.01
Chromium	0.23	5.0	0.05
Lead	0	5.0	0.05
Selenium	0.005	1.0	0.01
Silver	0.0	5.0	0.05
Mercury	0	0.2	0.002

Note: In reviewing the data, the Tobaccoville data appeared to be up to date (4/89) and complete. But the available data for the Bailey and Whitaker Park plants dated back to 1979 and appeared incomplete on the constituents. It would be recommended that a complete analysis of the E.P. Toxicity for the Bailey and Whitaker Park ashes be preformed prior to further analysis of structural fill applications.

End of Section

SECTION 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 General

This preliminary study sought to evaluate the potential for utilization of fly ash from the Bailey Plant, Tobaccoville Plant and Whitaker Park Plant in structural fill applications. Three (3) samples, five gallons each, were collected by KBK in December, 1988 for testing. In addition RJR supplied environmental data in April, 1989. After review of the physical and chemical data several conclusions and recommendations are warranted when considering the fly ashes' utilization potential.

7.2 Bailey Plant

Of the three (3) ash samples tested, the Bailey Plant fly ash exhibited the most favorable characteristics for use as structural fill. The physical tests indicate that the fly ash can be used as fill for non-load, low traffic bearing embankments such as recreational fields, landscape areas, and landscape berms. The tests indicate potential that the fly ash can be used as structural fill for load bearing areas such as pavement areas or building foundations, but it is recommended that further testing be performed prior to proceeding with such projects. The Standard Penetration Tests (ASTM D3441) and Triaxial Sheer Test (ASTM D2850) should be performed to determine the bearing capacity of the fly ash in order that foundations and pavement structures can be properly designed. Also, the tests indicate that the fly ash is susceptible to frost action and capillary rise. Structural fill embankments should be designed to prevent frost action and capillary rise from occurring and causing any detriment in the engineered properties of the embankment.

The Loss on Ignition indicates a moderately low level of carbon; therefore, settlement due to deterioration would be limited.

As for the environmental suitability of the fly ash for structural fills, it is recommended that additional E.P. Toxicity data be collected. The RJR E.P. Toxicity data indicates the ash has relatively low levels of heavy metals, therefore, the issuance of a utilization permit is possible. Specific site suitability for the utilization project would be required for any large project or for landfill siting. It is recommended that E.P. Toxicity analysis on representative samples be collected annually at a minimum.

7.3 Tobaccoville Plant

Based on physical characteristics, the Tobaccoville Plant fly ash does not have the necessary properties to be used as structural fill for load bearing areas or for non-load bearing areas which would be subject to light traffic such as recreational fields. The fly ash may be used for non-load bearing, non-traffic applications such as landscaping berms.

Though the fly ash shows very limited promise as structural material for which this evaluation was intended, it does indicate potential for utilization in waste water treatment. The high carbon content and low leachability of the Tobaccoville fly ash are desirable properties for filter applications. Also, the material's ability to "absorb" water at almost 70% of its dry weight would indicate a potential for use of the fly ash for sludge stabilization. These types of applications are usually area and project specific and would require mix testing prior to use.

To determine the environmental suitability, the E.P. Toxicity should be current and a site specific evaluation would be required. E.P. Toxicity analysis should be repeated on an annual basis.

7.4 Whitaker Park

Because the Whitaker Park Plant fly ash shows a sensitivity to moisture when not at optimum, its value as a structural fill material is questionable. The physical tests indicate that the fly ash may be used only in non-load bearing applications such as recreational fields and landscape areas without closer analysis. While this material could have some potential for low load bearing traffic areas, additional physical tests and close placement supervision would be required.

The Loss on Ignition indicates a moderately low level of carbon, therefore, settlement due to deterioration would be limited.

As for the environmental suitability of the fly ash for structural fills, it is recommended that additional E.P. Toxicity data be collected. The RJR E.P. Toxicity data indicates the ash has relatively low levels of heavy metals, therefore, the issuance of a utilization permit is possible. Specific site suitability for the utilization project would be required for any large project or for landfill siting. It is recommended that E.P. Toxicity analysis on representative samples be collected annually at a minimum.

7.5 Combination Uses

In order to locate one ash utilization project or disposal site for the three (3) sources of ash, the engineering properties of each ash is important to the combined ash structural performance. The test data indicates distinguishable differences in each fly ash. The most important parameter in determining combined use potential is the consolidation characteristics. Since the expected settlement from each ash is different, a structural fill constructed using a combination of the three ashes could be subject to differential settlement.

It is recommended that the three (3) fly ash materials not be combined in a structural fill where differential settlement cannot be tolerated. Proper blending and mixing could overcome this condition; however, the costs would likely be prohibitive.

Where the ash is used as a structural fill embankment (or landfilled), the test data indicates that attention should be directed to moisture control within the fill area. The fine particle size and sensitivity to moisture addition could result in a loss of stability of the fill if water enters the ash. A common result of water intrusion into a unsupported fill of this type of fly ash is a slope failure or "blow out". It is recommended that surface water and ground water intrusion be avoided for ash fill sites.

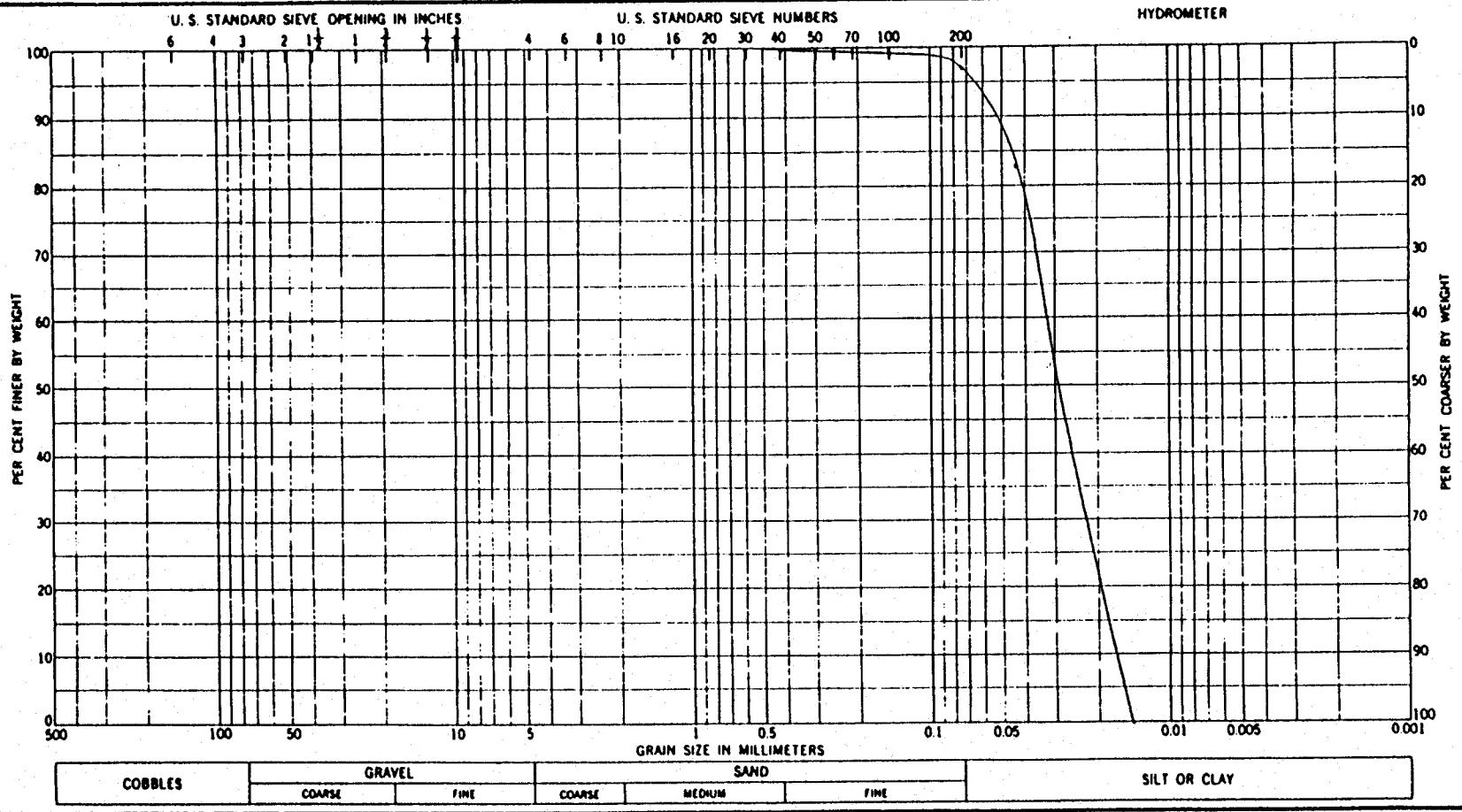
End of Section

APPENDIX 1
PHYSICAL CHARACTERIZATION TEST DATA

Project R.J. REYNOLDS

Job No. 32-82027

Date 12/20/88



Boring No.	Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
-	-	-	Coal Fly Ash, Bailey Plant.	-	-	-	-

GRADATION CURVES

ATEC Associates, Inc.
of Georgia
1190 Hayes Industrial Drive, N.E.
Marietta, Georgia 30062
404-427-9456

© Associates, Inc.
1300 Williams Drive
Marietta, Georgia 30066
404/427-9456

REPORT OF: MOISTURE DENSITY TEST
ASTM D-698, METHOD A, STANDARD

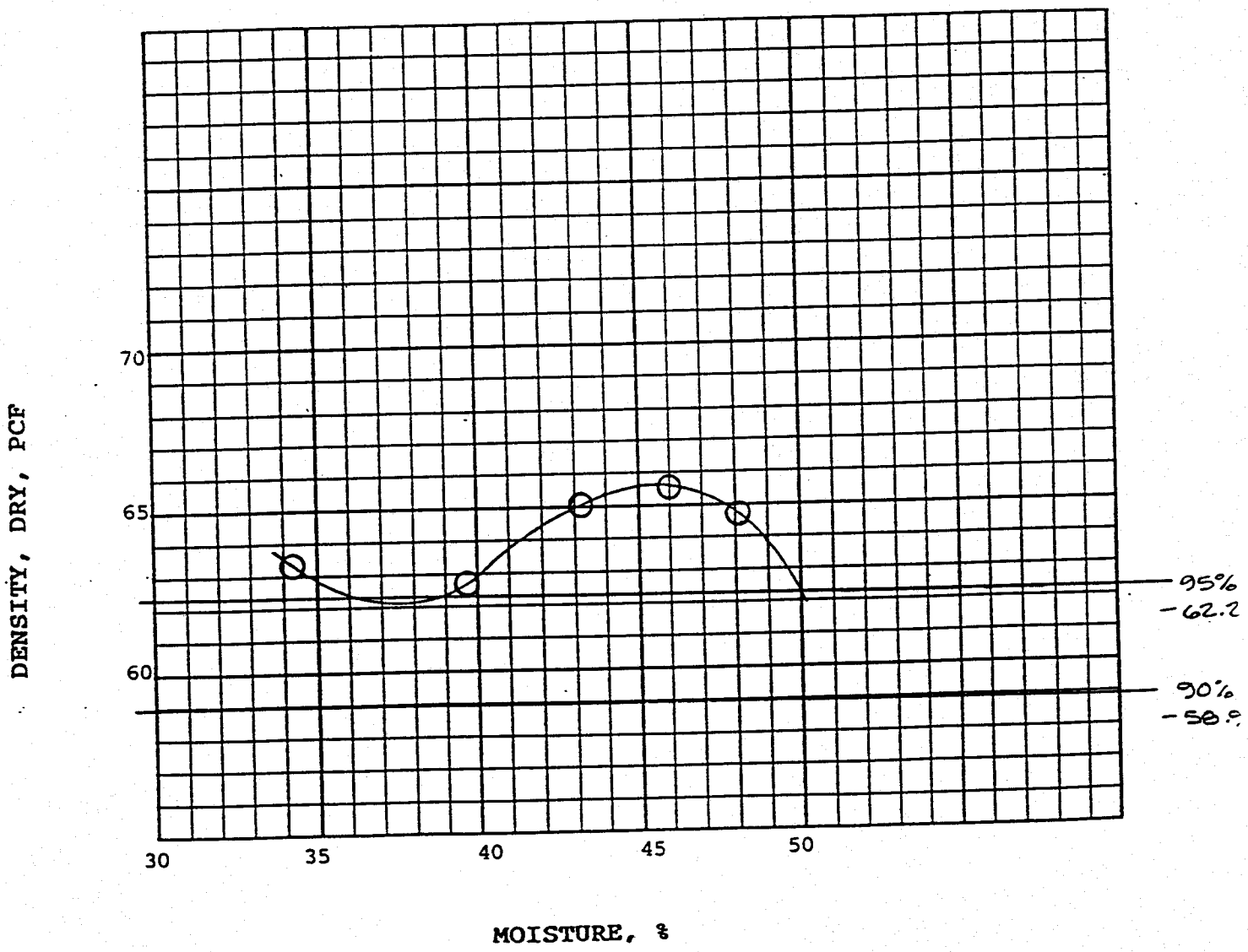
Date: 1/9/89

ct: R.J. REYNOLDS

Job No.: 32-82027

t: KBK Enterprises, Incorporated

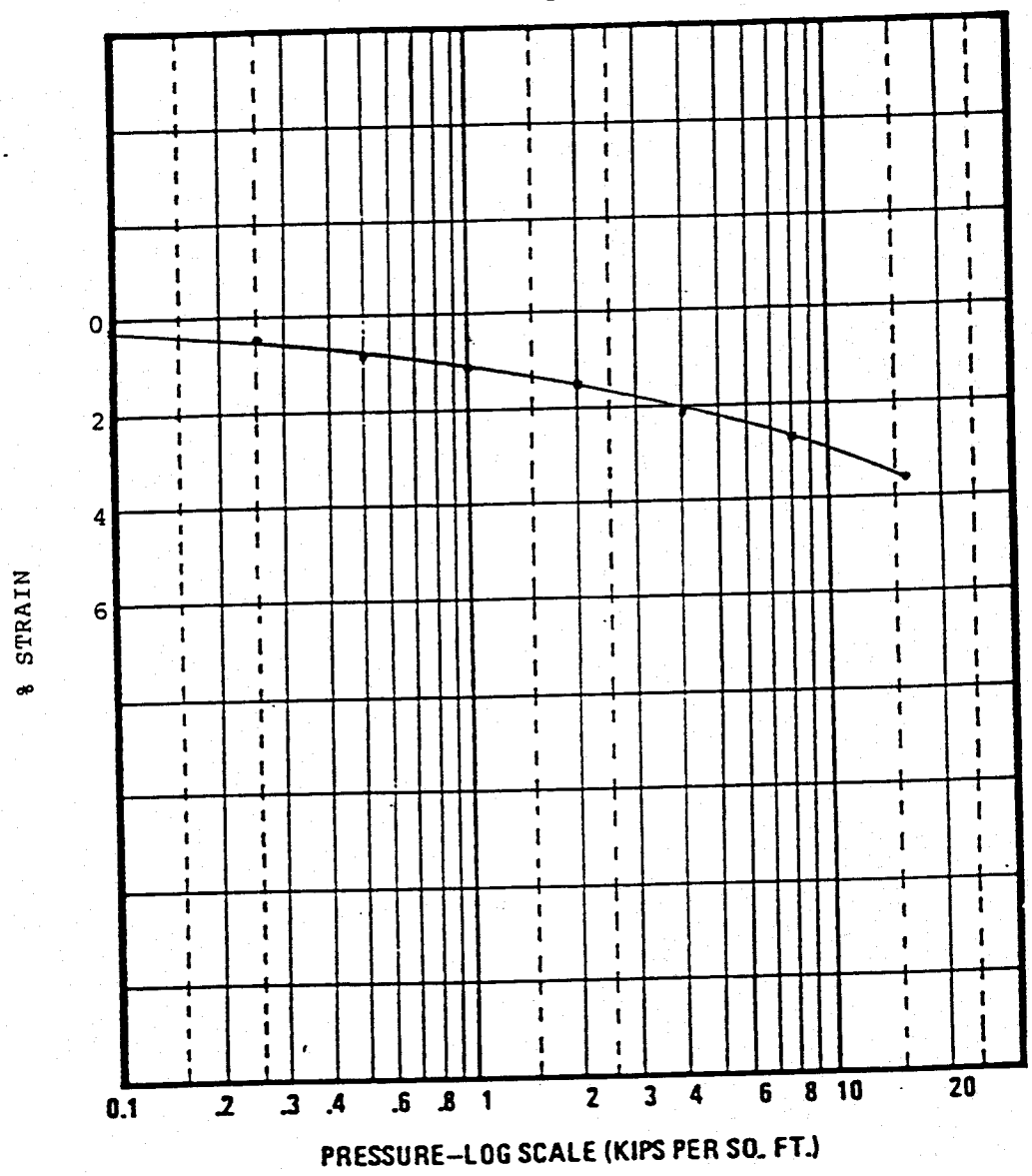
MATERIAL: Coal Fly Ash, Bailey Plant.
MAXIMUM DRY DENSITY: 65.5 PCF.
OPTIMUM MOISTURE CONTENT: 46.0%.



PROJECT R.J. REYNOLDS
CLIENT: KBK Enterprises, Inc.

DESCRIPTION Coal Fly Ash,
Bailey Plant.

COMPRESSION INDEX	0.07	
DRY UNIT WEIGHT (PCF)	62.7	- 95.7%
WATER CONTENT (%)	43.1	- 2.9%
SATURATION (%)	76.1	
LIQUID LIMIT	-	
PLASTIC LIMIT	-	



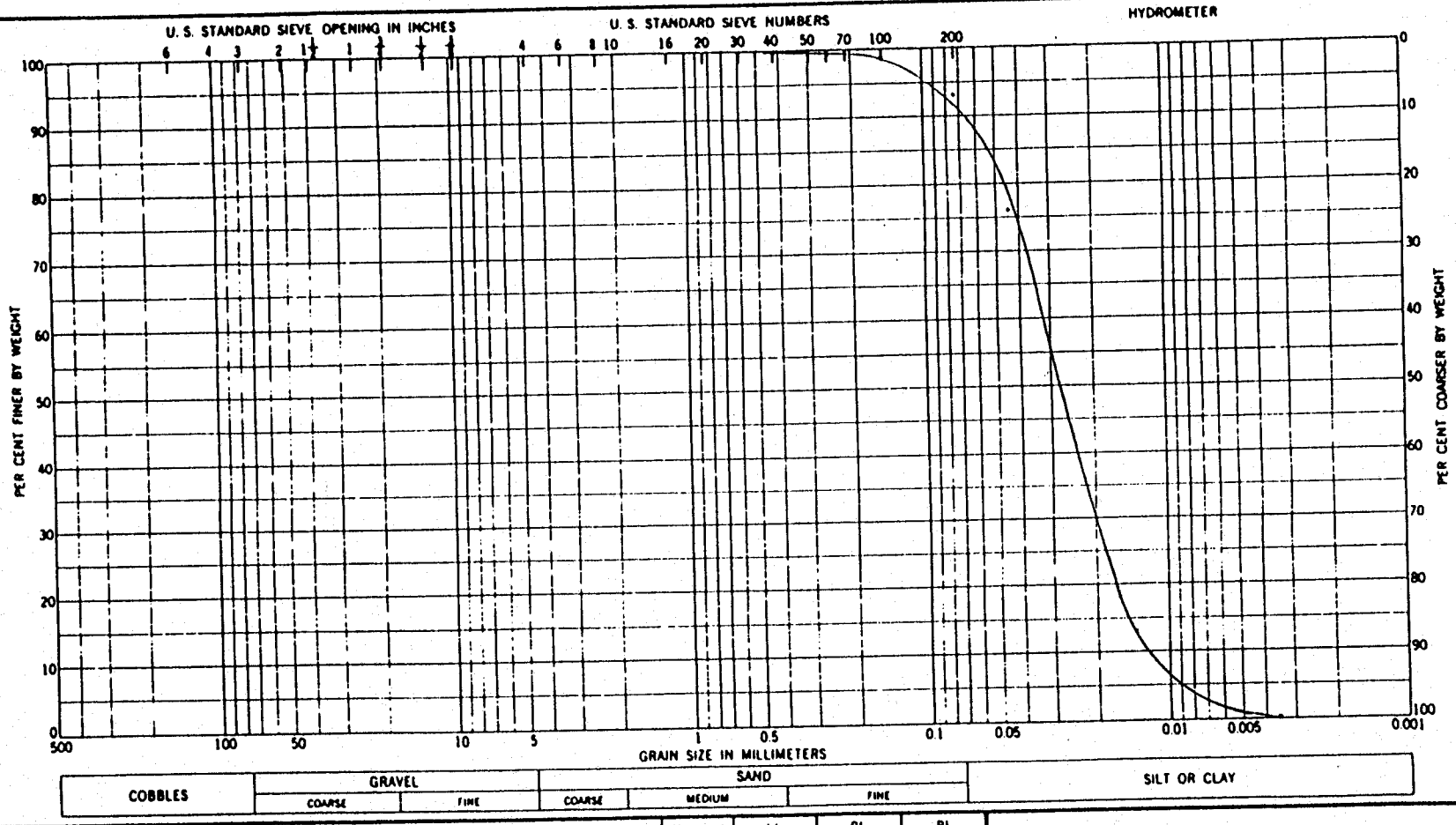
CONSOLIDATION TEST RESULTS

ATEC
ASSOCIATES, INC.

Project R.J. REYNOLDS

Job No. 32-82027

Date 12/20/88



Boring No	Sample No	Elev or Depth	Classification	Nat w %	LL	PL	PI
-	-	-	Coal Fly Ash, Tobaccoville Plant.	-	-	-	-

GRADATION CURVES

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© Associates, Inc.
1300 Williams Drive
Marietta, Georgia 30066
404/427-9456

REPORT OF: MOISTURE DENSITY TEST
ASTM D-698, METHOD A, STANDARD

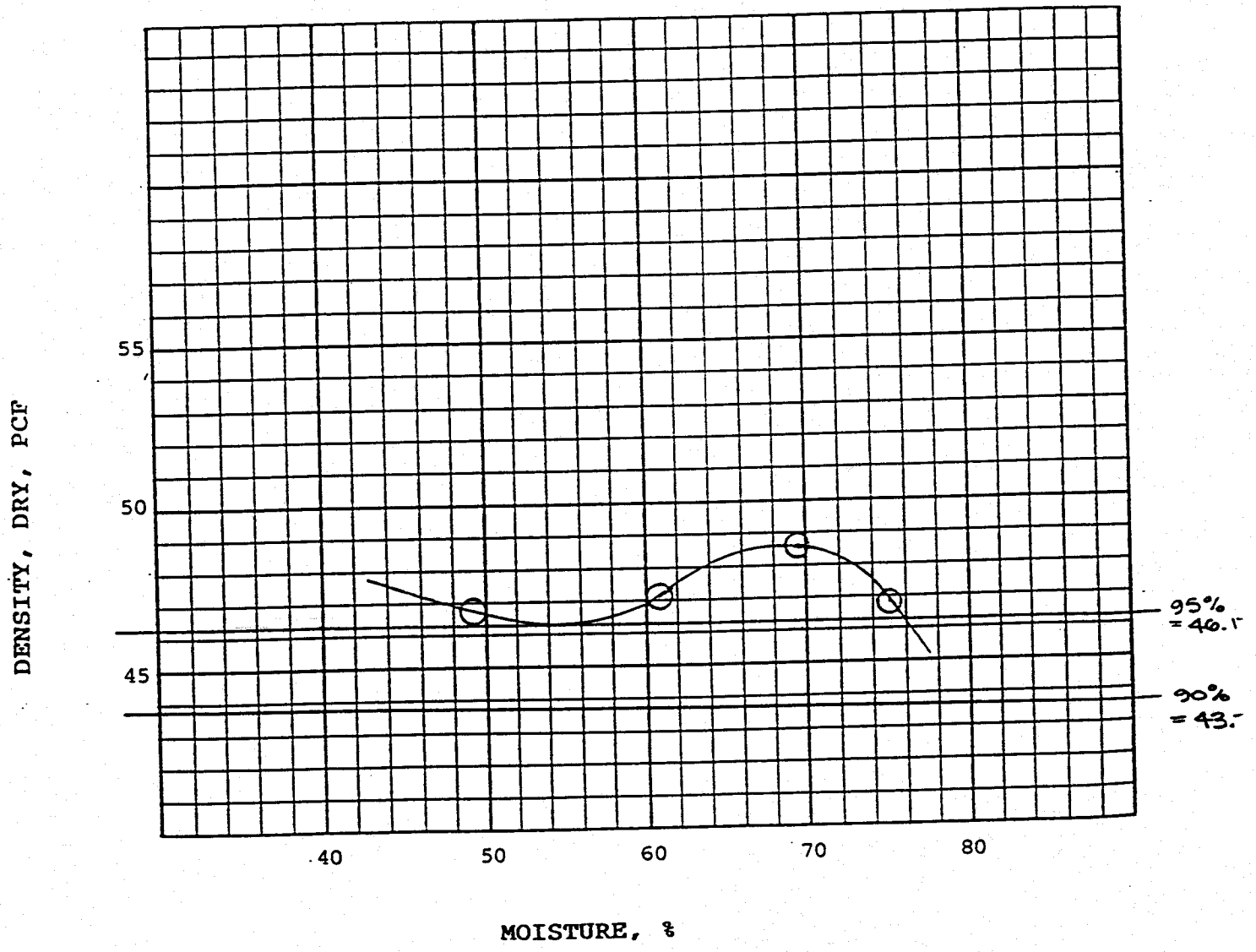
Date: 1/9/89

ect: R.J. REYNOLDS

Job No.: 32-82027

t: KBK Enterprises, Incorporated

MATERIAL: Coal Ash, Tobaccoville Plant.
MAXIMUM DRY DENSITY: 48.6 PCF.
OPTIMUM MOISTURE CONTENT: 69.8%.



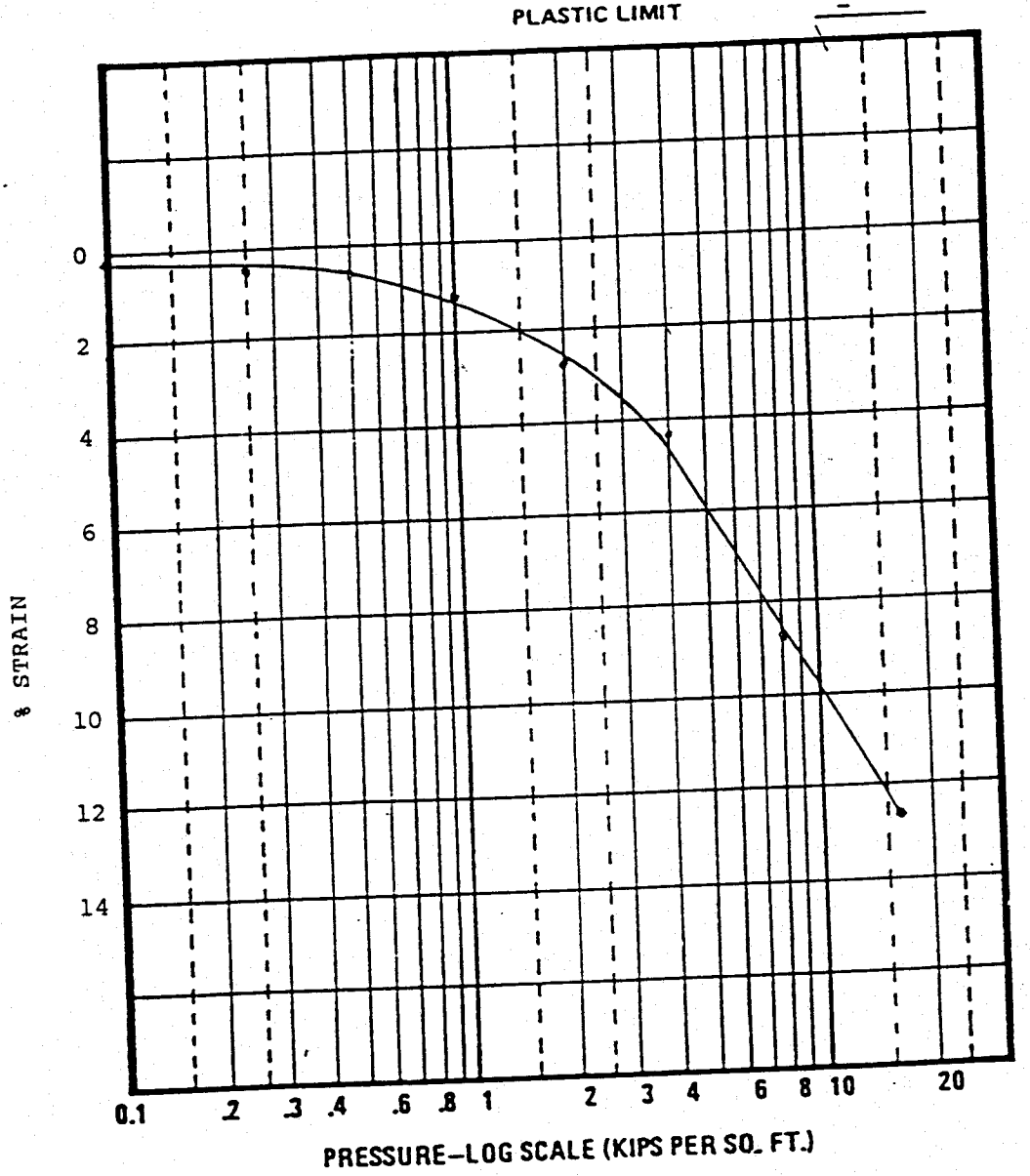
J.R.

PROJECT R.J. REYNOLDS

CLIENT: KBK Enterprises, Inc.

DESCRIPTION Coal Fly Ash, Tobaccoville Plant

COMPRESSION INDEX	0.41	
DRY UNIT WEIGHT (PCF)	45.8	- 54.2%
WATER CONTENT (%)	68.9	- 0.9%
SATURATION (%)	73.8	
LIQUID LIMIT	-	
PLASTIC LIMIT	-	



CONSOLIDATION TEST RESULTS

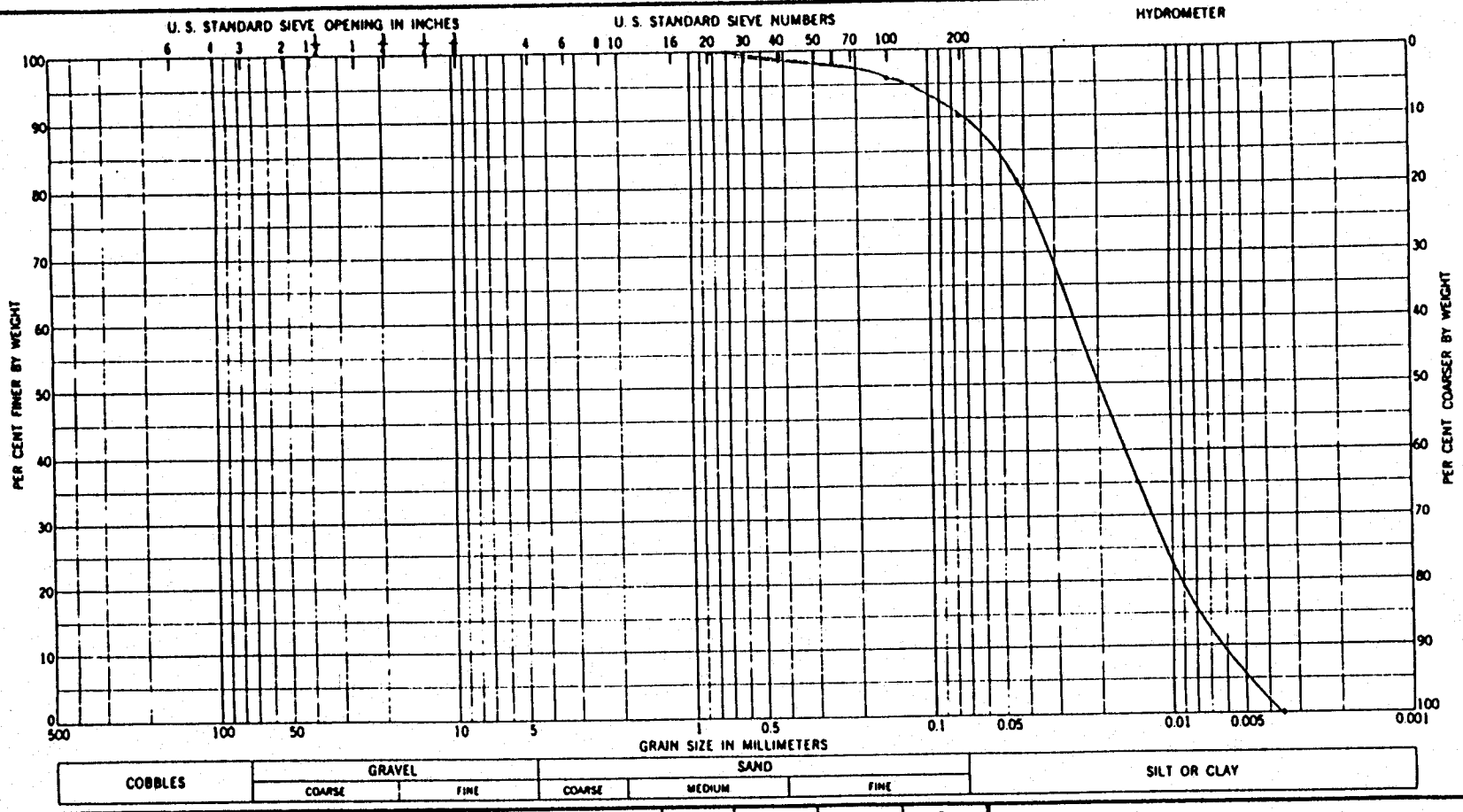
ATEC

ATEC ASSOCIATES, INC.

Project R.J. REYNOLDS

Job No. 32-82027

Date 12/20/88



Boring No.	Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
-	-	-	Coal Fly Ash, Whitacker Park.	-	-	-	-

GRADATION CURVES

ATEC Associates, Inc.
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EC Associates, Inc.
1300 Williams Drive
Marietta, Georgia 30066
404/427-9456

REPORT OF: MOISTURE DENSITY TEST

ASTM D-698, METHOD A, STANDARD

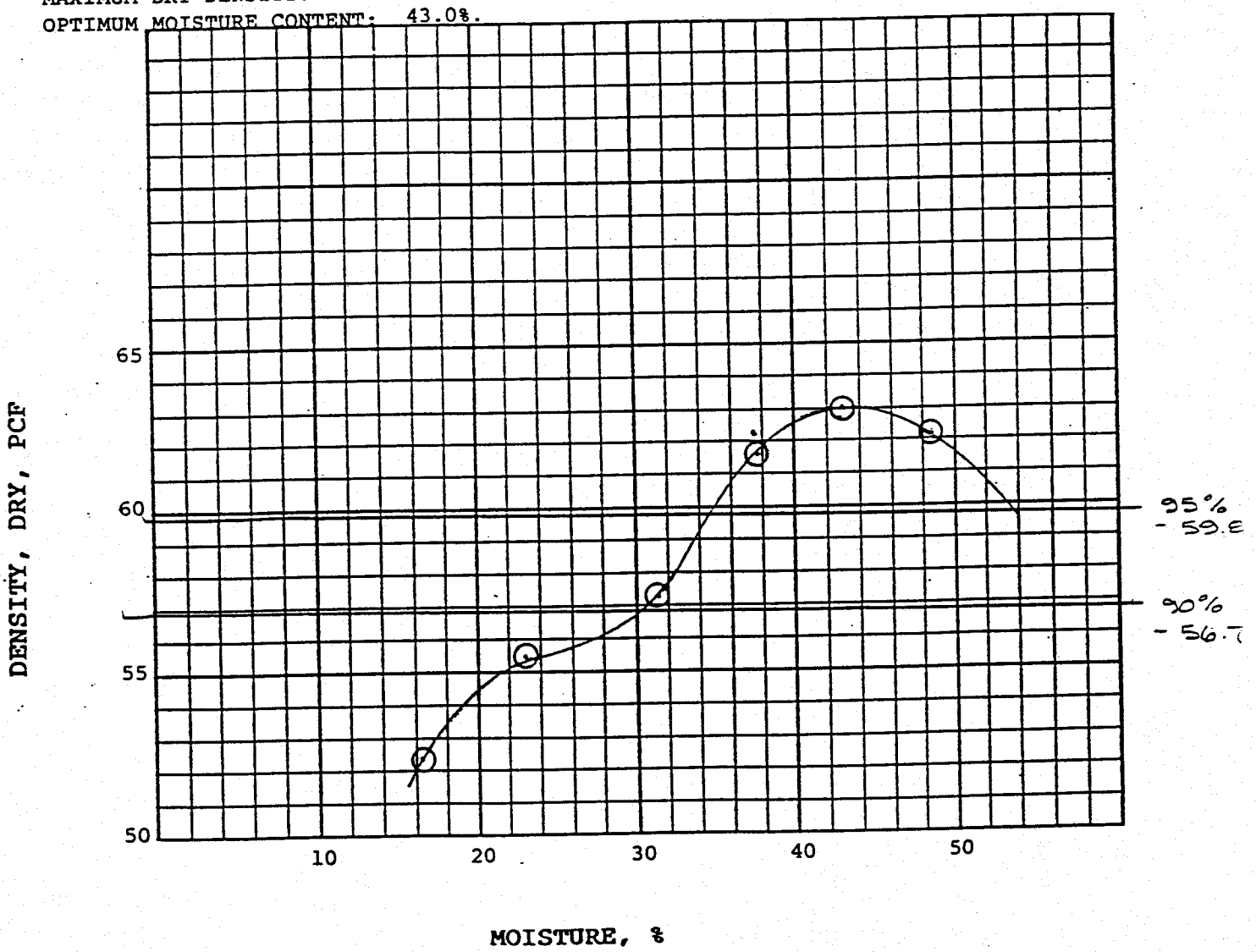
ect: R.J. REYNOLDS

nt: KBK Enterprises, Incorporated

Date: 1/9/89

Job No.: 32-82027

MATERIAL: Coal Fly Ash, Whitacker Park Plant.
MAXIMUM DRY DENSITY: 63.0 PCF.
OPTIMUM MOISTURE CONTENT: 43.0%.

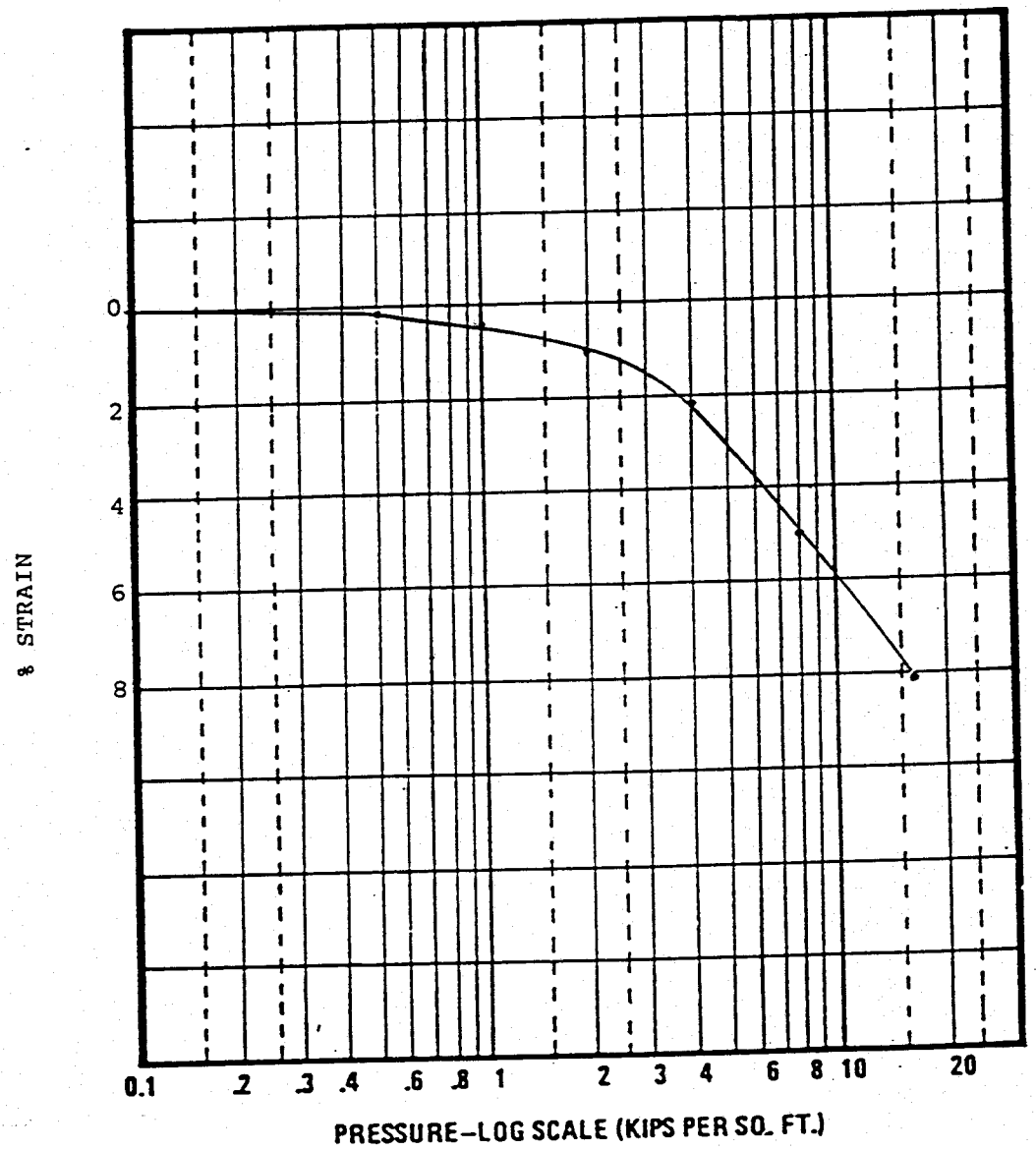


PROJECT R.J. REYNOLDS

CLIENT: KBK Enterprises, Inc.

DESCRIPTION Coal Fly Ash, Whitacker Park Plant

COMPRESSION INDEX	0.25
DRY UNIT WEIGHT (PCF)	62.3 - 95.9%
WATER CONTENT (%)	38.9 - 4.1%
SATURATION (%)	62.3
LIQUID LIMIT	-
PLASTIC LIMIT	-



CONSOLIDATION TEST RESULTS

ATEC

ATEC ASSOCIATES, INC.

R.J. REYNOLDS TOBACCO COMPANY

	SAMPLE 1	SAMPLE 2	SAMPLE 3
PLANT	WHITAKER PARK	BAILEY POWER PLANT	TOBACCO-VILLE
MOISTURE CONTENT			
AVG.	1.3%	28.3%	39.0%
LOSS ON IGNITION			
AVG.	17.73%	8.7%	25.41%

TESTED BY JDP

DATE TESTED 1/3/89

SIGNED H.B. Fitzgerald

APPENDIX 2
E.P. TOXICITY DATA

RESEARCH & ANALYTICAL LABORATORIES, INC.

N.C. CERT. #54

25 February 1985

R.J. Reynolds Tobacco Company
11th Floor Plaza Building
Winston-Salem, NC 27102

Attention: Mr. Bill Howard

Sample Number: 4844
Sample Date: February 4, 1985
Sample Received: February 4, 1985
Sample Analyzed: February 4-25, 1985
Report Date: February 25, 1985
Sample Source: #1 Fly Ash
Analysts: Vaden/Champion

PARAMETER	EP TOXICITY NUMBER	RESULTS (mg/l)	SPIKE I (mg/l)	% RECOVERY	SPIKE 2 (mg/l)	% RECOVERY	SPIKE 3 (mg/l)	% RECOVER
Arsenic	D-004	0.024	0.022	101%	0.044	102%	0.11	102%
Barium	D-005	1.7	1.0	100%	2.5	115%	5.0	97%
Cadmium	D-006	< 0.0050	0.040	111%	0.080	100%	0.10	100%
Chromium	D-007	< 0.010	0.10	100%	0.20	94%	0.30	100%
Lead	D-008	< 0.10	0.40	100%	1.25	100%	2.0	100%
Mercury	D-009	< 0.0050	0.010	107%	0.020	100%	0.030	104%
Selenium	D-010	< 0.0030	0.0060	108%	0.012	94%	0.025	89%
Silver	D-011	< 0.010	0.040	100%	0.080	100%	0.16	107%

P. O. Box 473 • 106 Short Street • Kernersville, North Carolina 27284 • 919/996-2841

RESEARCH & ANALYTICAL LABORATORIES, INC.

Analytical/Process Consultations

R.J. Reynolds Tobacco Company
P.O. Box 2959, P/LS-F1.4A
Winston-Salem, NC 27102
Attn: Bill Howard

Date Sample Collected : 03/22/89
Date Sample Received : 03/22/89
Date Sample Analyzed : 03/23/89
Date of Report : 04/10/89
Analyses Performed by : CS

Job Number : 00419 K

Lab Sample Number
52726

Parameter	Storet #	Results
Arsenic, Tot	RCRA(D-004)	< 0.010 mg/l
Barium, Tot-	RCRA(D-005)	0.015 mg/l
Cadmium, Tot	RCRA(D-006)	<0.010 mg/l
Chrom. Tot-	RCRA (D-007)	0.029 mg/l
Lead, Tot	RCRA (D-008)	<0.10 mg/l
Selenium Tot	RCRA(D-010)	0.051 mg/l.
Silver, Tot	RCRA(D-011)	<0.016 mg/l...
Mercury, Tot	RCRA(D-009)	0.0003 mg/l

Clients Sample Source/Number TOBACCOVILLE FLY ASH

XC: CLM

P.O. Box 473 • 106 Short Street • Kernersville, North Carolina 27284 • 919/996-2841

EP TOX 1980

TABLE III

TOXICANT LEVEL IN EXTRACT

Sample Description	Date of Sample	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
Blank		0	0	0	0.02	0	0	0	0
Blank		0	0	0	0	0	0	0	0
Blank		0	0	0	0.01	0	0	0	0
Fly Ash #2 Silo	3/13/79	0	0.2	0	0.02	0	0	0.013	0
B.P.P. Wet Ash Hydrobin	3/15/79	0	1.0	0	0	0	0	0	0
B.P.P. Wet Ash Hydrobin	3/15/79	0	1.467	0	0	0	0	0	0.0
B.P.P. Fly Ash	3/16/79	0	0	0	0	0	0	0.032	0.0
B.P.P. Wet Ash Hydrobin	3/20/79	0	0.867	0	0.02	0	0	0	0.0
B.P.P. Fly Ash #2 Silo	3/22/79	0	0	0	0.01	0	0	0.007	0.0
B.P.P. Wet Ash Hydrobin	3/23/79	0	0.800	0	0.01	0	0	0	0.0
B.P.P. Fly Ash #2 Silo	3/23/79	0	0.200	0	0.02	0	0	0.018	0.0
B.P.P. Fly Ash #1 Silo	3/27/79	0	0	0	0.02	0	0	0	0.0
B.P.P. Wet Ash #1 Load	3/28/79	0	0.800	0	0.02	0	0	0	0.0
B.P.P. Wet Ash Last Load	3/28/79	0	0.867	0	0	0	0	0	0
B.P.P. Fly Ash #2 Silo	3/30/79	0	0.267	0	0.01	0	0	0	0.0
B.P.P. Wet Ash Hydrobin	4/2/79	0	0.800	0	0	0	0	0	0
B.P.P. Fly Ash #1 Silo	4/4/79	0	0	0	0	0	0	0	0
B.P.P. Wet Ash Hydrobin	4/5/79	0	1.200	0	0.01	0	0	0	0
B.P.P. Fly Ash #1 Silo	4/5/79	0	0.333	0	0	0	0	0	0.0
W.P.P. Precip. Dust	3/14/79	0.1	0.200	0.15	0.13	0	0	0	0.0
W.P.P. Boiler Ash	3/14/79	0	0.467	0	0.01	0	0	0	0.0
W.P.P. Precip. Dust	3/21/79	0.1	0	0.15	0.23	0	0	0.005	0.0
W.P.P. Boiler Ash	3/21/79	0	0.400	0	0	0.1	0	0	0.0
W.P.P. Precip. Dust	3/28/79	0	0.200	0.15	0.01	0	0	0.063	0.0
W.P.P. Boiler Ash	3/28/79	0	0.267	0	0.02	0	0	0	0.0
W.P.P. Precip. Dust	4/5/79	0	0	0.09	0.01	0	0	0.007	0
W.P.P. Boiler Ash	4/5/79	0	0.800	0	0	0	0	0	0.0

DATE

B.P.P. — BAILEY POWER PLANT

WPP — WHITAKER PARK PLANT

KBK Enterprises, Inc.
A SUBSIDIARY OF JTM INDUSTRIES, INC.

777 FRANKLIN ROAD, SUITE 700
MARIETTA, GEORGIA 30067
(404) 426-5944

3191 SOUTH VALLEY STREET, SUITE 208
SALT LAKE CITY, UTAH 84109
(801) 484-3131

APPENDIX IV

(Correspondence)

GCI
GEO-ENVIRONMENTAL
CONSULTANTS, INC.

February 24, 1993

Ms. Sherie Hoyt
North Carolina Department of Environment,
Health, and Natural Resources
Solid Waste Section
Post Office Box 27687
Raleigh, North Carolina 27611-7687

Subject: Proposed R.J. Reynolds
Phase III Flyash Management Area

Dear Ms. Hoyt:

This letter is written to confirm our conversations on February 22 and 23, 1993 regarding the submittal of a permit application for the proposed R.J. Reynolds, Phase III Flyash Management Area.

Based on our conversations, it is our understanding that there are no current regulations for flyash disposal in the State of North Carolina and that the permit application for the proposed flyash management area must be prepared in accordance with 15A NCAC 13B, Section 0.0504, Application Requirements for Sanitary Landfills. It is also our understanding that an EPA Subtitle D liner will not be required for the proposed flyash management area, and that a compacted subgrade will be sufficient for the proposed disposal activities.

As part of the flyash management area submittal we will also be providing a characterization of the flyash waste stream that will indicate the "inert" nature of the waste material. This characterization will include a program for testing the flyash to confirm that it is inert matter similar to the material that is placed in demolition landfills. All flyash material that cannot be characterized as "inert" waste material will not be placed at the R.J. Reynolds Phase III Flyash Management Area. It is our understanding that the flyash waste product will generally be considered a non-hazardous industrial waste, and if the waste stream coming into the facility is controlled as described above then it will not be subject to the requirements of the EPA Subtitle D.

Since the flyash management regulations are still in the process of development, we would like to work with the NCDEHNR Solid Waste Section in recommending design and operation recommendations that have been used successfully in other parts of the country and will provide reasonable protection for human health and the environment. During the preparation of the permit application, we will be submitting information periodically for comment by the NCDEHNR Solid Waste Section. We would appreciate a timely response from your office as to the acceptance or non-acceptance of these recommended design or operation criteria since these responses govern the preparation of our permit application.

Thank you for your assistance in the interpretation of the NCDEHNR current policy toward flyash management. If you have any questions regarding the contents of this letter please do not hesitate to contact our office at (704) 332 - 2060.

Sincerely,

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Christopher D. Hardin, P.E.
Senior Project Engineer

AAC\RJRPH3.LET

cc: Carl Martin, R.J. Reynolds
Steve Mason, ETPA

GEO-ENVIRONMENTAL
CONSULTANTS, INC.

April 7, 1993

Mr. Lanny Gough
Winston-Salem Inspections Division
100 Liberty Walk
Winston-Salem, N.C. 27101

Subject: R.J. Reynolds Fly Ash Land Management Area Expansion
Phase III

Dear Mr. Gough,

R.J. Reynolds currently owns/operates a fly ash land management area on Edwards Road (S.R. 1903) in Forsythe Co. The existing operation is comprised of approximately 20 acres being progressively filled in with fly ash generated from R.J.R.'s Bailey, Tobaccoville and Whitaker plants. The existing terrain of the property prohibits any type of development, due to the extremely steep slopes. R.J. Reynolds, as part of their progressive land management program intends to continue filling the property to attain grades sufficient for other beneficial uses, such as a park and recreation area.

Geo-Environmental Consultants, Inc. (hereinafter referred to as "GCI") is currently working with R.J. Reynolds in the expansion of their existing operation into a new phase. The new phase, shown as Phase III on the attached Exhibit Map, will incorporate approximately 30 additional acres into their land management area.

The fly ash generated from the R.J.R. facilities is a byproduct of a coal burning process which generates energy. Fly ash is considered an inert material, as defined by technical waste characterization models depicting the levels of compounds present relative to the Environmental Protection Agencies limits. R.J.R.'s fly ash has consistently tested well within the E.P.A. limits for a solid waste for the past several years and exhibits characteristics similar to a silty sand. In addition, the fly ash is a uniformly graded material and has no odor.

In North Carolina, the regulation of industrial waste falls under the authority of the North Carolina Department of Environment, Health and Natural Resources (NCDEHNR). Permits to dispose of industrial wastes such as fly ash are issued by NCDEHNR. Conditional permits are also issued for the utilization of fly ash in markets such as structural fill, certain backfill, ice control, pipe bedding, concrete aggregate and certain other uses.

NCDEHNR currently has no regulations which specifically apply to the permitting of a fly ash management area. GCI, in a cooperative effort with NCDEHNR, is in the process of developing industry standards for the operation and maintenance of fly ash disposal facilities in North Carolina. Such standards will consist of a comprehensive approach to the maintenance and monitoring needs for these types of facilities. Soil borings and groundwater monitoring wells will be installed in and around the facility to determine necessary hydrogeologic considerations prior to commencement of filling. Once filling commences in Phase III, there will be periodic sampling of the ground water and surface runoff to assure compliance will all E.P.A. discharge limits.

For the past seven years, R.J.R. has placed several hundred thousand cubic yards of fly ash on the subject property. The management of this existing operation includes a comprehensive monitoring program of on-site groundwater and surface water. The fly ash from the three facilities is also tested at the source to assure compliance with all E.P.A. guidelines, a program which exceeds the current North Carolina monitoring standards. The results from these monitoring efforts have consistently been favorable with no negative environmental impacts.

The Forsythe County Zoning Regulations address only demolition landfill and sanitary landfill permits. R.J. Reynolds fly ash management facility does not meet the criteria of either of those definitions. Due to this project being a lateral expansion of a previously permitted facility regulated by the State of North Carolina and the inert nature of the material being filled, R.J.R. requests a letter from the Forsythe County Zoning Department stating that the proposed expansion of this facility is allowed under the current zoning regulations and would not be affected by future zoning amendments, obviously this type of zoning approval would be contingent upon receipt of an acceptable permit from the NCDEHNR.

GCI would like to work closely with Forsythe County in keeping you informed of the permitting process with North Carolina and provide to you all information pertinent to this project. If you have any questions regarding the contents of this letter, please do not hesitate to contact our office at (704) 332-2060.

Sincerely,

GEO-ENVIRONMENTAL CONSULTANTS, INC.

Chris N. Isaacs

Chris N. Isaacs
Project Manager
ACC\RJRFYTHE.LET

State of North Carolina
Department of Environment, Health, and Natural Resources
512 North Salisbury Street • Raleigh, North Carolina 27604

James B. Hunt, Jr., Governor

Division of Solid Waste Management
Telephone (919)733-0692

Jonathan B. Howes, Secretary

April 22, 1993

Mr. James D. Ponder
Geo-environmental Consultants, Inc.
1016 McClelland Court
Charlotte, N.C. 28206

Re: Conditional Approval of the Boring Plan for the Geologic and Hydrogeologic Study for the R.J. Reynolds Fly Ash Landfill Expansion Area, Phase III

Dear Mr. Ponder,

This letter is in response to the Boring Plan that was recently submitted to our office by Geo-environmental Consultants, Inc. on behalf of R.J. Reynolds. As discussed in our telephone conversation earlier this afternoon, overall the Boring Plan looks sufficient, however I would make the following comments and suggestions:

1. The proposed Monitoring Plan for Phase III should be submitted after reviewing the information provided by the hydrogeologic investigation based on the boring program.

2. If monitoring wells W-4 and W-5 are planned to be used as part of the on-going detection monitoring system, it will be important that they are properly located, designed, and constructed.
   (a) Well W-4 should be located further away from the waste boundary if it is to be used as the background well.
   (b) Wells screened at the water table should use a 10 to 15 foot slotted screen that is sufficient to allow for seasonal fluctuations in the water table so that the water table will always fall within the screen and sufficient water is available to provide a representative sample of the aquifer even during seasonal low water table conditions.
   (c) If the water table occurs in the regolith and a well is to be screened in the bedrock, a type II well design would not be appropriate.

3. The report makes reference to a total of seven borings but describes and illustrates eight boring locations. It is my understanding that there are in fact eight total boring locations in the proposed Boring Plan.

P.O. Box 27687, Raleigh, North Carolina 27611-7687 Telephone 919-733-4984 Fax # 919-733-0513

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4. Since past borings at the site often did not encounter the water table above auger refusal, I would recommend placing a couple of borings in the drainage swale where they are more likely to encounter the water table in the saprolite.

5. Since the conceptual design indicates that waste will be disposed of nearly up to the ridge line on the south side of the disposal area, the monitoring plan should provide for monitoring the south side of the landfill unit.

I hope these comments will be useful to you as you finalize the boring plan for the hydrogeologic investigation of the Phase III area. If you have any questions or comments, you may contact me here at (919) 733-0692.

Sincerely,

Bobby Lutfy

Bobby Lutfy
Hydrogeologist
Solid Waste Section

INSPECTIONS
DIVISION

City of Winston-Salem

PUBLIC WORKS
DEPARTMENT

May 4, 1993

Mr. Chris N. Isaacs
Geo-Environmental Consultants, Inc.
1016 McClelland Court
Charlotte, NC 27205

Subject: R. J. Reynolds Fly Ash
Landfill Expansion Phase III

Dear Mr. Issacs:

Currently the Forsyth County Zoning Ordinance only governs sanitary landfills. Demolition landfills are not listed within the table of permitted uses, but it will be considered a grading operation. As long as the State does not classify this site as a sanitary landfill there are no zoning permit(s) required. Grading permits may be required for this site therefore you should contact Tommie Beeding with Erosion Control at (919) 727-2389. Should the State ever classify this as a sanitary landfill all requirements of the Forsyth County Zoning Ordinance must be met. In addition, the Forsyth County Commissioners must also approve the landfill. I am enclosing a copy of the County Code that requires the approval from the County Commissioners.

If I can be of any further assistance feel free to contact me at (919) 727-2626.

Cordially,

Lanny Gough

Lanny Gough
Zoning Plans Examiner

LG/pg

100 Liberty Walk/NCNB Plaza
Winston-Salem, North Carolina 27101

GEO-ENVIRONMENTAL
CONSULTANTS, INC.

September 8, 1993

Mr. Randy Williams
N.C. Wildlife Resources Commission
Division of Wildlife Management
512 N. Salisbury Street
Raleigh, North Carolina 27604-1188

Re: R.J. Reynolds Ash Management Area

Mr. Williams:

Enclosed please find a site exhibit for a proposed ash management area owned and operated by R.J. Reynolds Tobacco Company in Forsythe County.

The North Carolina Department of Environment, Health and Natural Resources requires a letter stating that the proposed site shall not cause or contribute to the taking of any endangered or threatened species of plants, fish or wildlife and the project shall not result in the destruction or adverse modification of the critical habitat of endangered or threatened species as identified in 50 C.F.R Part 17.

Please remit the letter to the office of Geo-Environmental Consultants, Inc. If your have any questions regarding the contents of this letter, please do not hesitate to contact our office at (704) 332-2060. Thank you for your assistance on this matter.

Sincerely,

GEO-ENVIRONMENTAL CONSULTANTS, INC,

Chris N. Isaacs
Project Manager

Christopher D. Hardin
Senior Project Engineer

GEO-ENVIRONMENTAL
CONSULTANTS, INC.

September 8, 1993

Mr. David Brook
State Historic Preservation Office
109 East Jones Street
Raleigh, North Carolina 27601

Re: R.J. Reynolds Ash Management Area

Mr. Brook:

Enclosed please find a site exhibit for a proposed ash management area owned and operated by R.J. Reynolds Co. in Forsythe County.

The North Carolina Department of Environment, Health and Natural Resources requires a letter from your agency stating that the proposed project shall not damage or destroy any archaeological or historical site and the project shall no cause an adverse impact on a state park, recreation or scenic area, or any other lands included in the state nature and historic preserve.

Please remit the letter to the office of Geo-Environmental Consultants, Inc. If your have any questions regarding the contents of this letter, please do not hesitate to contact our office at (704) 332-2060. Thank you for your assistance on this matter.

Sincerely,

GEO-ENVIRONMENTAL CONSULTANTS, INC,

Chris N. Isaacs

Chris N. Isaacs
Project Manager

Christopher Hardin

Christopher D. Hardin
Senior Project Engineer

SECTION .1700 - BENEFICIAL USE OF COAL COMBUSTION BY-PRODUCTS

.1701 DEFINITIONS

The following definitions shall apply throughout this Section:

(1) "Coal combustion by-products" means residuals, including fly ash, bottom ash, boiler slag and flue gas desulfurization residue produced by coal fired electrical or steam generation units. For purposes of these standards, this definition does not include residuals removed from a permitted waste water treatment facility, which is regulated by the Division of Environmental Management.

(2) "Structural fill" means an engineered fill with a projected beneficial end use, constructed using coal combustion by-products placed and compacted with proper equipment.

(3) "Beneficial" means promoting public health and environmental protection, offering equivalent success relative to other alternatives, yielding a savings of natural resources and offering either economic profitability or minimization of liability.

(4) "Use or reuse of coal combustion by-products" means the procedure whereby coal combustion by-products are directly employed in one of the following:

(a) As an ingredient in an industrial process to make a product, unless distinct components of the coal combustion by-products are recovered as separate end products or

(b) In a function or application as an effective substitute for a commercial product or natural resource.

(5) "Department" means the Secretary of the Department of Environment, Health, and Natural Resources or his authorized representative.

.1702 GENERAL PROVISIONS FOR STRUCTURAL FILL FACILITIES

The provisions of this Rule shall apply to the siting, design, construction, operation, closure and recordation of projects which utilize coal combustion by-products as structural fill material and shall apply to all structural fills other than those which received specific written approval from the Division. A solid waste management permit is not required for coal combustion by-products structural fills which meet the requirements listed in this Section.

.1703 NOTIFICATION FOR STRUCTURAL FILL FACILITIES

(a) At least 30 days before using coal combustion by-products in any structural fill projects, the person proposing the use shall submit a written notice to the Division. The notice shall contain, at a minimum:

(1) A description of the nature, purpose and location of the project, including an eight and one-half by 11 inch topographic map showing the project and the name of the United States Geological Survey seven and one-half minute map on which the project is located.

(2) The estimated beginning and ending dates for the project.

(3) An estimate of the volume of coal combustion by-products to be used for the project.

SAMPLING?

(4) An appropriate leaching analysis from a representative sample of each significantly different coal combustion by-product source to be used in the project. A minimum analysis shall include: arsenic, barium, cadmium, lead, mercury, selenium and silver.

(5) A signed statement by the owner of the land on which the structural fill is to be placed, acknowledging and consenting to the use of coal combustion by-products as structural fill.

(b) In addition to the notification requirements under Paragraph (a) of this Rule, at least 30 days before using coal combustion by-products as a structural fill in projects with a volume of more than 10,000 cubic yards, the person proposing the use shall submit a written notice to the Division containing construction plans for the structural fill, including a stability analysis when necessary, which shall be prepared by a registered professional engineer in accordance with sound engineering practices and which shall be signed and sealed by the engineer.

(c) The Department shall approve or deny any exception to these provisions within 30 days of receipt of the required notification.

.1704 SITING FOR STRUCTURAL FILL FACILITIES

Coal combustion by-products used as a structural fill shall not be placed:

(1) Within 50 horizontal feet of any regularly flowing water body or stream, unless a greater distance is required for monitoring or potential corrective action.

(2) Within two feet of the seasonal high water table, unless otherwise approved by the Division.

(3) Within 100 horizontal feet of any source of drinking water, such as a well, spring or other groundwater source of drinking water, unless otherwise approved by the Department.

(4) Within an area subject to a one-hundred year flood, unless it can be demonstrated that the facility can be protected from inundation, and washout, and the flow of water is not restricted and the storage volume of the flood plain will not be significantly reduced unless otherwise approved by the Division,

(5) Within a wetland,

(6) Within 25 feet of any topographically down gradient property boundary, unless otherwise approved by the Division, and

(7) Within 25 feet of a bedrock outcrop, unless otherwise approved by the Division.

.1705 DESIGN, CONSTRUCTION, AND OPERATION FOR STRUCTURAL FILL FACILITIES

(a) The structural fill must be designed, constructed, operated, maintained, and closed in such a manner as to minimize the potential for harmful release of constituents of coal combustion by-products to the environment and minimize potential for harm or nuisance to the public.

(b) Coal combustion by-products shall be collected and transported in a manner that will prevent nuisances and hazards to public health and safety. To prevent dusting, coal combustion by-products shall be moisture conditioned and transported in covered trucks.

(c) Coal combustion by-products shall be placed uniformly and compacted in lifts not exceeding one foot in thickness. Each lift shall be compacted to an in-situ density of at least

90% of the standard Proctor maximum dry density as determined by American Society for Testing and Materials Test Designation D 698 or to a minimum of 80% relative density as determined by American Society for Testing and Materials Test Designation D 4254 for coal combustion bottom ash and boiler slag.

(d) Equipment shall be available which is capable of placing and compacting the coal combustion by-products, and capable of handling the earthwork required during the periods that coal combustion by-products are received at the fill area.

(e) The coal combustion by-product structural fill facility shall be effectively maintained and operated as a non-discharge system to prevent discharge to surface water resulting from the operation of the facility.

(f) The coal combustion by-product structural fill facility shall be effectively maintained and operated such that there are no violations of 15A NCAC 2L.

(g) Non-contact surface waters shall be diverted away from the active coal combustion by-product placement area during filling and construction activity.

(h) Site development shall not violate with the North Carolina Sedimentation Pollution Control Act of 1973, as amended.

(i) The structural fill project must be operated with sufficient dust control measures to minimize air born emissions and to prevent dust from creating a nuisance or safety hazard and must not violate air quality regulations.

(j) All structural fills shall be covered with a minimum of 12 inches compacted earth, the surface six inches of which shall be able to support the growth of suitable vegetation.

(k) Compliance with these standards does not preclude any of the owners and operators from damages to surface waters, groundwater or air resulting from the operation of the structural fill facility. In the event that the facility fails to perform in accordance with the requirements of this Section, the constructor, generator, owner or operator shall notify the Division and shall take such immediate corrective action as may be required by the Department.

(l) Coal combustion by-products utilized on an exterior slope of a structural fill shall not be placed with a slope greater than 3.0 horizontal to 1.0 vertical.

.1706 CLOSURE OF STRUCTURAL FILL FACILITIES

(a) No later than 30 working days or 60 calendar days, whichever comes first after coal combustion by-product placement has ceased, the final cover shall be applied over the coal combustion by-product placement area, unless the Division is notified in writing.

(b) The final surface of the structural fill shall be graded and provided with drainage devices in a manner that:

(1) Minimizes erosion of cover materials and

(2) Promotes drainage of precipitation falling on the area, minimizes infiltration and prevents the ponding of surface water on the structural fill.

(c) Other erosion control measures, including but not limited to, temporary mulching, seeding, or silt barriers shall be installed such that there is no visible coal combustion by-product migration to adjacent properties and as necessary until the beneficial end use of the project is realized.

.1707 RECORDATION OF STRUCTURAL FILL FACILITIES

(a) The owner of land where coal combustion by-products have been utilized in volumes of more than 1,000 cubic yards shall file a notarized statement of the volume and locations of the coal combustion by-products with the register of deeds' office in the county or counties where the property is located.

(b) Recordation shall be required within 90 days after completion of coal combustion by-product fill project.

(c) The register of deeds shall record the notarized statement and index it in the grantor index under the name of the owner of the land. The register of deeds shall index the notarized statement in the grantor index under the name of the landowner. The original notarized statement shall be returned to the Division after recording.

(d) When any land with more than 1,000 cubic yards of coal combustion by-products is sold, leased, conveyed or transferred in any manner, the deed or other instrument of transfer shall contain in the description section in no smaller type than used in the body of the deed or instrument a statement that coal combustion by-products have been used as fill on the property.

.1708 OTHER USES FOR COAL COMBUSTION BY-PRODUCTS

Coal combustion by-products may be beneficially used on one or more of the following applications or when handled, processed, transported or stockpiled for such beneficial use applications and do not require a solid waste permit provided the uses are consistent with the requirements identified below:

(1) Coal combustion by-products used as soil nutrient additives, or other agricultural purposes under the authority of the North Carolina Department of Agriculture,

(2) Coal combustion bottom ash or boiler slag used as a traction control material or road surface material if the use is consistent with North Carolina Department of Transportation specifications and approved by the Department of Transportation,

(3) Coal combustion by-products used as material in the manufacturing of another product, including but not limited to, concrete products, lightweight aggregate, roofing materials, plastics, paint, flowable fill and roller compacted concrete or as a substitute for a product or material resource, including but not limited to, blasting grit, roofing granules, filter cloth precoat for sludge dewatering and pipe bedding,

(4) Coal combustion by-products used as a structural fill for the base, sub-base or under a structure or the footprint of a paved road, a parking lot, sidewalk, walkway or similar structure,

(5) Coal combustion by-products used for the extraction or recovery of materials and compounds contained within the coal combustion by-products. Residuals from the processing operations shall remain solid waste and be subject to these standards and

(6) Coal combustion by-products which have been processed with a cementitious binder to produce a stabilized structural fill product which is spread and compacted with proper equipment for the construction of a project with a planned end use.

.1709 STORAGE AND CONTAINMENT OF COAL COMBUSTION BY-PRODUCTS

(a) Coal combustion by-products may not be stored or speculatively accumulated at the immediate area where they will be put to beneficial use for a longer period of time than

necessary to complete the project. Coal combustion by-products are not being speculatively accumulated when a minimum of 75% of the coal combustion by-products are removed from the facility and beneficially used annually.

(b) Coal combustion by-products shall be stored and contained in a manner which complies with the North Carolina Water Pollution Control Regulations (15 NCAC 2H), the North Carolina Air Pollution Control Regulations (15A NCAC 2D) and all other federal, state and local laws and regulations.

.1710 ANNUAL REPORTING

No later than October 1, 1993 and each October thereafter, the generators of coal combustion by-products shall submit an annual summary to the Division. The annual summary shall be for the period September 1 through August 31. The annual summary shall include:

(1) Volume of coal combustion by-products produced,
(2) Volume of coal combustion by-products disposed,
(3) Volume of coal combustion by-products used in structural fill facilities and
(4) Volume of coal combustion by-products used for other uses as described in Rule .1708.